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<b>(51) International Patent Classification <sup>6</sup> :</b> <b>A61K 31/445, C07D 211/14</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 97/23216</b> <b>(43) International Publication Date:</b> 3 July 1997 (03.07.97)
<b>(21) International Application Number:</b> PCT/US96/20872 <b>(22) International Filing Date:</b> 20 December 1996 (20.12.96) <b>(30) Priority Data:</b> 60/009,184 22 December 1995 (22.12.95) US <b>(71) Applicants (for all designated States except US):</b> WARNER-LAMBERT COMPANY [US/US]; 201 Tabor Road, Morris Plains, NJ 07950 (US). COCENSYS, INC. [US/US]; 213 Technology Drive, Irvine, CA 92618 (US). <b>(71)(72) Applicants and Inventors:</b> BIGGE, Christopher, F. [US/US]; Apartment #6, 1856 Stadium Place, Ann Arbor, MI 48103 (US). CAI, Sui, Xiong [CN/US]; 12 Salinas, Foothill Ranch, CA 92610 (US). WEBER, Eckard [US/US]; 1290 Morningside, Laguna Beach, CA 92651 (US). WOODWARD, Richard [GB/US]; 95 Sandcastle, Alison Viejo, CA 92656 (US). KEANA, John, F., W. [US/US]; 3854 Onyx Street, Eugene, OR 97405 (US). LAN, Nancy, C. [US/US]; 522 Hermosa Street, South Pasadena, CA 91030 (US). GUZIKOWSKI, Anthony, P. [US/US]; 2647 Quince Street, Eugene, OR 97404 (US). ZHOU, Zhang-Lin [CN/US]; 15 Bearpaw #12-A, Irvine, CA 92604 (US). YEUN, Po-Wai [GB/US]; 2178 Maple Creek Circle, Ann Arbor, MI 48108 (US).		<b>(74) Agents:</b> MANDRA, Raymond, R.; Fitzpatrick, Cella, Harper & Scinto, 277 Park Avenue, New York, NY 10172 (US) et al. <b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> 4-SUBSTITUTED PIPERIDINE ANALOGS AND THEIR USE AS SUBTYPE SELECTIVE NMDA RECEPTOR ANTAGONISTS  <b>(57) Abstract</b>  Novel 4-substituted piperidine analogs, pharmaceutical compositions containing the same and the method of using 4-substituted piperidine analogs are selective active antagonists of N-methyl-D-aspartate (NMDA) receptor subtypes for treating conditions such as stroke, cerebral ischemia, central nervous system trauma, hypoglycemia, psychosis, anxiety, migraine headaches, glaucoma, CMV retinitis, aminoglycoside antibiotics-induced hearing loss, convulsions, chronic pain, opioid tolerance or withdrawal, urinary incontinence or neurodegenerative disorders, such as lathyrism, Alzheimer's Disease, Parkinsonism and Huntington's Disease are described.		

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## TITLE

4-SUBSTITUTED PIPERIDINE ANALOGS AND THEIR  
USE AS SUBTYPE SELECTIVE NMDA RECEPTOR ANTAGONISTS

## BACKGROUND OF THE INVENTION

## Field of the Invention

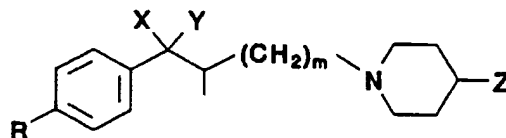
5 This invention is related to 4-substituted piperidine  
analogs, including hydroxypiperidine and  
tetrahydropyridine analogs. The analogs are  
selectively active as antagonists of N-methyl-D-  
aspartate (NMDA) receptor subtypes. The invention is  
10 also directed to the use of 4-substituted piperidine  
analogs as neuroprotective agents for treating  
conditions such as stroke, cerebral ischemia, central  
nervous system trauma, hypoglycemia, anxiety,  
psychosis, glaucoma, CMV retinitis, urinary  
15 incontinence, aminoglycoside antibiotics-induced  
hearing loss, convulsions, migraine headache, chronic  
pain, opioid tolerance or withdrawal, or neuro-  
degenerative disorders such as lathyrism, Alzheimer's  
Disease, Parkinsonism and Huntington's Disease.

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## Related Background Art

Excessive excitation by neurotransmitters can cause the degeneration and death of neurons. It is believed that this degeneration is in part mediated by the excitotoxic actions of the excitatory amino acids (EAA) glutamate and aspartate at the N-methyl-D-Aspartate (NMDA) receptor. This excitotoxic action is considered responsible for the loss of neurons in cerebrovascular disorders such as cerebral ischemia or cerebral infarction resulting from a range of conditions, such as thromboembolic or hemorrhagic stroke, cerebral vasospasms, hypoglycemia, cardiac arrest, status epilepticus, perinatal asphyxia, anoxia such as from drowning, pulmonary surgery and cerebral trauma, as well as lathyrism, Alzheimer's Disease, Parkinson's Disease and Huntington's Disease.

Various classes of substituted piperidine analogs are known. For example, EP 0648744 generically discloses phenylalkanol derivatives described by the formula

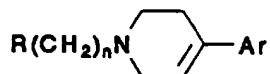


wherein R is hydrogen, hydroxy, or aryl lower alkyloxy; X is hydrogen; Y is hydroxy or hydrogen; or both X and Y taken together are oxygen; Z is aryl lower alkyl; and m is an integer from 1 to 4. The phenylalkanol derivatives of this reference are indicated to be NMDA receptor antagonists that are useful to reduce toxic injury to central neurons and may be used to treat ischemia, stroke or hypoxia. This reference does not disclose or suggest the 4-substituted piperidine analogs of this invention or their use as selective NMDA receptor subtype antagonists.

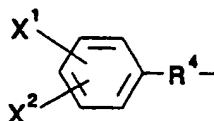


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- Other piperidine derivatives having aryl alkanol functionality are disclosed by PCT International Publication No. WO 93/11107 (for treating hypoxia and ischaemia), International Publication No. WO 94/10166 (for treating stroke, addiction, pain, epilepsy, psychosis, traumatic brain injury and CNS degenerative diseases), EP 0398578 (for treating stroke or CNS degenerative diseases, Alzheimer's disease, Huntington's disease and Parkinson's disease) and PCT International Publication No. WO 93/02052 (for treating stroke, traumatic injury to the brain and spinal cord, and neuronal degenerative diseases). Similar to EP 0648744, each of these references requires a piperidine derivative having an alkyl hydroxy or keto group alpha to the aryl group of the N-1 substituent. The 4-substituted piperidine analogs of this invention differ in kind from the piperidine derivatives of these references.
- EP 0445701 generically discloses tetrahydropyridine derivatives described by the formula



- wherein Ar is phenyl or thienyl which may have identically or differently one or two substituents selected from the group consisting of lower alkyl, lower alkoxy, halogen, substituted or unsubstituted phenyl, trifluoromethyl and hydroxy; n is an integer of from 2 to 6; R is hydroxy or a group of the formula:

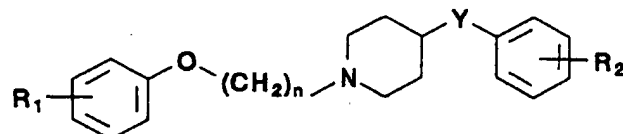


- wherein R<sup>1</sup> is hydrogen or lower alkyl; R<sup>2</sup> and R<sup>3</sup> each is hydrogen or lower alkyl or taken together with the

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adjacent nitrogen atom may form a 5- or 6- membered heterocyclic group, which may be condensed with a benzene ring, where the heterocyclic group may identically or differently have 1 to 3 substituents  
5 selected from the group consisting of lower alkyl, halogen, oxo, pyrimidine, and substituted or unsubstituted phenyl;  $R^4$  is NH, O, or a single bond;  $X^1$  and  $X^2$  each is hydrogen, lower alkyl, halogen, or hydroxy; p and q each is an integer of 0 or 1, except  
10 that p is 0 when q is 1. These tetrahydropyridines are said to have high affinity and specificity to  $\sigma$  receptors and thus may be effective for treating depression, mania and acute and chronic schizophrenia, and cerebral ischemic disease. There is no disclosure  
15 or suggestion of NMDA receptor subtype selectivity.

FR 2681319 discloses 1-(phenoxy-alkyl) piperidine derivatives represented generically by the formula

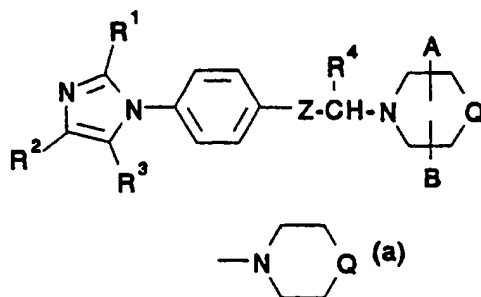


20 wherein  $R_1$  and  $R_2$  are independently selected from hydrogen, halogen, methoxy or trifluoromethyl, n is 3 or 4 and Y is  $-CH_2-$ ,  $-CH_2CH_2-$ ,  $-OCH_2-$  or  $-CH_2O-$ . The reference indicates that these piperidine derivatives  
25 are useful for treating cerebral disorders, dementia and other neurodegenerative disorders. The 4-substituted piperidine analogs of this invention or their use as selective NMDA receptor subtype antagonists is not disclosed or suggested.

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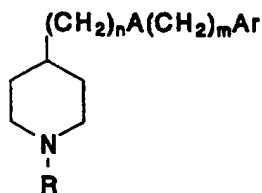
PCT International Publication No. WO 94/18172 generically discloses imidazolybenzene compounds represented by the formula

- 5 -



wherein  $R^1$ ,  $R^2$  and  $R^3$  are independently selected from hydrogen, halogen, nitro, cyano, amino, alkyl, acyl, phenyl or alkoxy;  $R^4$  is hydrogen, alkyl or cycloalkyl; Z is  $-CH_2-$ ,  $-CH(OH)-$  or  $-CO-$ ; the ring (a) is piperidyl or 1-piperazinyl; A is hydrogen, hydroxy or alkyl; and B is cycloalkyl, cycloalkylalkyl, acyl, aryl, aralkyl, heteroaryl or heteroarylalkyl. The imidazolybenzene compound is said to be useful as an NMDA antagonist and cranial nerve cell death inhibitor. However, there is no disclosure of NMDA subtype receptor selectivity.

PCT International Publication Number WO 92/02502 generically discloses N-hydrocarbyl 4-substituted piperidines described by the formula:

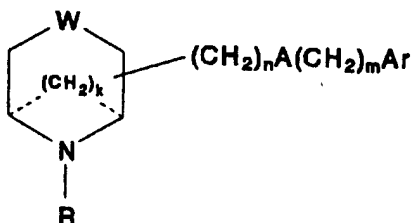


in which  
 $R$  is  $C_{1-8}$ alkyl(phenyl)p,  $C_{2-8}$ alkenyl(phenyl)p,  $C_{2-8}$ alkynyl(phenyl)p,  $C_{3-8}$ cycloalkyl;  
 $p$  is 0 to 2;  
 $n$  is 0 to 6;  
 $A$  is a bond, oxygen, sulphur or  $NR^1$ ;  
 $R^1$  is hydrogen,  $C_{1-8}$ alkyl or phenyl  $C_{1-4}$ alkyl;  
 $m$  is 0 to 3; and

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Ar is aryl or heteroaryl, each of which may be optionally substituted; and salts thereof. This reference exemplifies 4-aryloxyalkyl piperidines. The substituted piperidines are said to be calcium channel  
 5 blockers expected to be useful in the treatment of anoxia, ischemia including stroke, migraine, epilepsy, traumatic head injury, AIDS-related dementia, neurodegenerative disorders and drug addiction. The reference does not disclose or suggest the particular  
 10 4-substituted piperidine analogs of this invention or their use as selective NMDA receptor subtype antagonists for the treatment of disorders responsive thereto.

15 PCT International Publication Number WO 93/15052 generically describes compounds that are said to be calcium channel antagonists broadly represented by the formula:

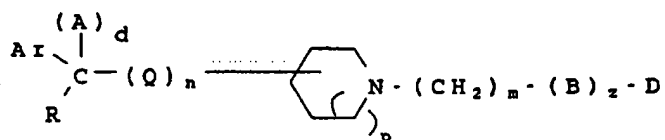


20 and the salts thereof, wherein W is  $-\text{CH}_2-$ , a bond, O or S; k is 0, or when W represents  $-\text{CH}_2-$  k may also be 2, in which case the dotted lines represent single bonds; R is  $\text{C}_{1-3}$ alkyl(phenyl)p,  $\text{C}_{2-3}$ alkenyl(phenyl)p,  
 25  $\text{C}_{2-3}$ alkynyl(phenyl)p,  $\text{C}_{3-3}$ cycloalkyl or  $\text{C}_{1-3}$ alkyl $\text{C}_{3-3}$ cycloalkyl, or R may also represent hydrogen when k is 2; p is 0 to 2  
 n is 0 to 6;  
 m is 0 to 6; and  
 30 A is a bond,  $-\text{CH}=\text{CH}-$ ,  $-\text{C}\equiv\text{C}-$ , oxygen, sulphur or  $\text{NR}^1$ ;  $\text{R}^1$  is hydrogen,  $\text{C}_{1-3}$ alkyl or phenyl $\text{C}_{1-4}$ alkyl; and Ar is aryl or heteroaryl, each of which may be optionally substituted; provided that: when W is a

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bond the side chain is  $\alpha$  to the ring nitrogen atom;  
 when W is  $\text{CH}_2$ , k is zero, the side chain is at the 3- or  
 4-position of the piperidine ring and A is a bond,  
 oxygen, sulphur or  $\text{NR}^1$  then Ar is aryl substituted by  
 5 phenoxy or substituted phenoxy or is a tricyclic  
 heteroaryl group as hereinafter defined; and when W is  
 $\text{CH}_2$  and k is 2 the side chain  $-(\text{CH}_2)_k\text{A}(\text{CH}_2)_m\text{Ar}$  is not  $\alpha$   
 to the nitrogen atom. This reference exemplifies  
 mostly 2 and 3 substituted piperidines. In addition,  
 10 the particular group of 3 and 4 substituted piperidines  
 described by the reference requires A to be  $-\text{CH}=\text{CH}-$  or  
 $-\text{C}=\text{C}-$ . This reference does not disclose or suggest the  
 4-substituted piperidine analogs of this invention.  
 Moreover, there is no suggestion of employing 4-  
 15 substituted piperidine analogs as selective NMDA  
 receptor subtype antagonists.

European Patent Application No. 235,463 generically  
 discloses calcium antagonists represented by the  
 20 formula



wherein;

p is zero, one or two;

25 A is hydrogen,  $-\text{O}-\text{R}^1$ ,  $-\text{C}=\text{N}$ ,  $-\text{C}(\text{O})\text{NR}^1\text{R}^2$ ,  $-\text{C}(\text{O})-\text{R}^1$ ,

$-\text{C}(\text{O})-\text{O}-\text{R}^1$ ,  $-\text{O}-\text{C}(\text{O})-\text{R}^1$ ,  $-\text{CH}_2\text{OR}^1$ ,  $-\text{CH}_2\text{NR}^1\text{R}^2$ ;

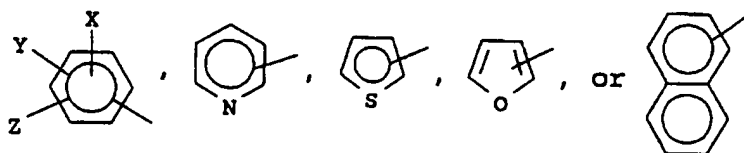
m is zero to six inclusive;

Q is  $-\text{CH}-$ ,  $-\text{CH}_2-$  or  $-\text{C}-$ ;  
 $\begin{array}{c} \text{OH} \\ | \\ -\text{C}- \\ | \\ \text{H} \end{array}$

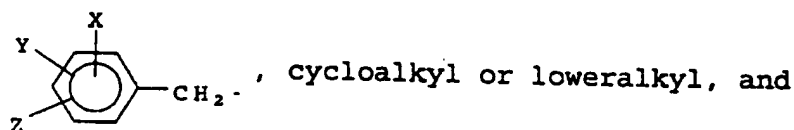
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d and n are selected from zero or one and the dotted lines represent double bonds which may form consistent with the valence of carbon;

Ar, D and R are selected from the group consisting  
5 of

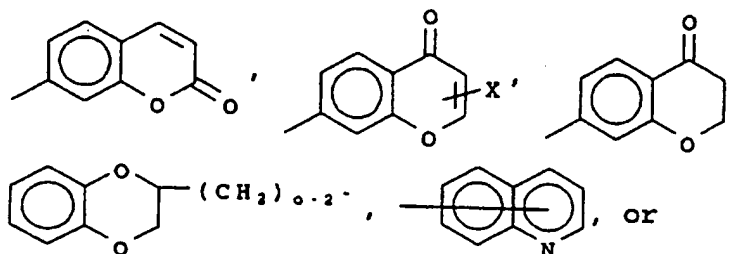


and in addition, R may have the values:

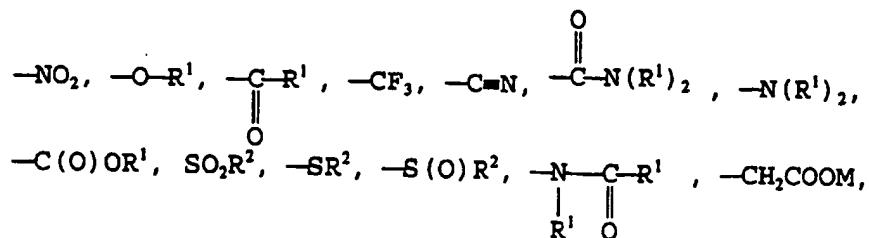


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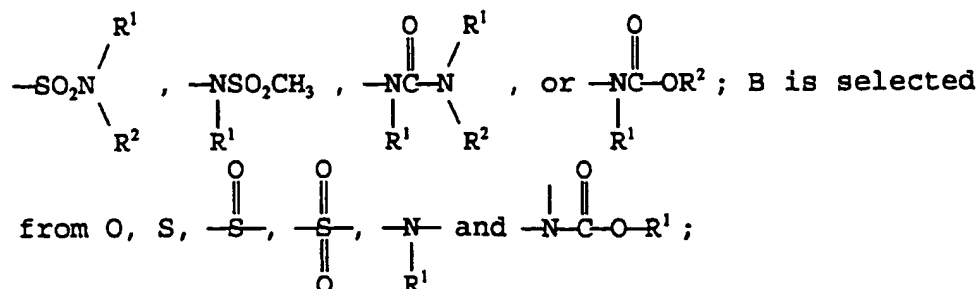
D may have additionally the values:

15 Ar(CH<sub>2</sub>)<sub>1-4</sub>,

X, Y and Z are selected from the group consisting of hydrogen, lower alkyl, halogen,

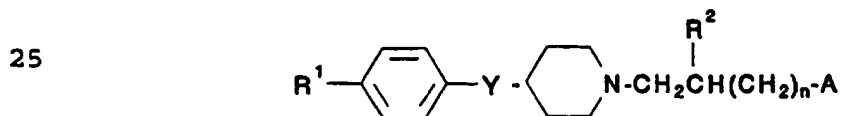


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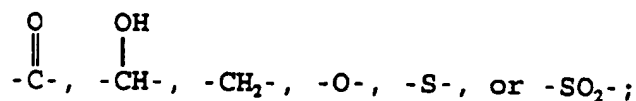
z is one or zero with the proviso that z cannot be zero at the same time n is zero when one of the following occurs at the same time that D is phenyl or substituted phenyl: (A)<sub>4</sub> is hydrogen, (A)<sub>4</sub> is cyano, (A)<sub>4</sub> is aminocarbonyl, or a double bond forms between the α carbon and a carbon of the central heterocyclic amine-ring; R<sup>1</sup> is selected from hydrogen, loweralkyl, phenyl and phenylloweralkyl; R<sup>2</sup> is selected from loweralkyl, phenyl and phenylloweralkyl; M is a pharmaceutically acceptable metal ion and the pharmaceutically acceptable salts thereof, including acid addition salts, quaternary salts, and hydrates and alcoholates thereof. This reference discloses that such compounds may be useful as coronary vasodilators, antihypertensives, antiarrhythmic, antiallergy, antihistamic and antisecretory agents. There is no suggestion or disclosure of the 4-substituted piperidines of this invention or their use as selective NMDA receptor subtype antagonists.

U.S. Patent No. 5,202,346 generically discloses a compound represented by the formula



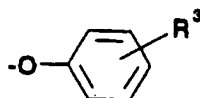
wherein R<sup>1</sup> is alkylsulfonamido of 1 to 6 carbon atoms, arylsulfonamide of 6 to 10 carbon atoms, -NO<sub>2</sub>, -CN, 1-imidazolyl or 1,2,4-triazol-1-yl; Y is

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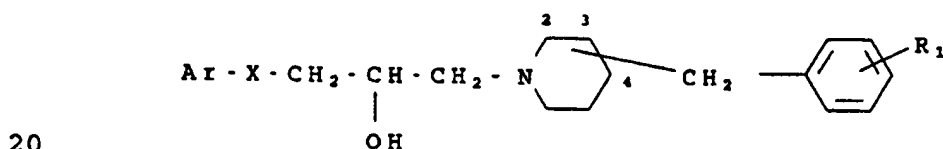
$R^2$  is hydrogen when  $n$  is 0, otherwise it is hydrogen or -OH;  $n$  is one of the integers 0, 1, 2, 3, 4, 5 or 6;  $A$  is

5



where  $R^3$  is alkylsulfonamide of 1 to 6 carbon atoms, arylsulfonamido of 6 to 10 carbon atoms,  $-\text{NO}_2$ ,  $-\text{CN}$ , 1-imidazolyl or 1,2,4-triazol-1-yl. These compounds are said to be Class III antiarrhythmic agents. JP 61-115068 discloses 4-benzylpiperidinypropoxyaniline derivatives, such as 2-(3-(4-benzyl-1-piperidiny)propoxy)aniline, also said to have antiarrhythmic, as well as local anesthetic action. No mention is made of NMDA antagonists, let alone selective subtype receptor antagonists.

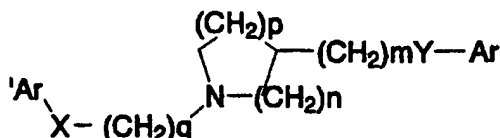
U.S. Patent No. 5,036,077 generically discloses piperidine derivatives described by the formula:



wherein Ar represents a phenyl group substituted by  $R_2$ ,  $R_3$  and  $R_4$  or a naphth-1-yl or naphth-2-yl group, substituted or unsubstituted by 1 or 2 halogen atoms; X represents an oxygen atom or sulfur atom;  $R_1$  represents H or a halogen atom;  $R_2$  represents a halogen atom, a trifluoromethyl group, a phenyl group which is unsubstituted or substituted by 1 to 3 halogen atoms, a phenoxy group which is unsubstituted or substituted by 1 to 3 halogen atoms, or a  $\text{C}_1$ - $\text{C}_4$  alkyl group and the benzyl group substitutes the piperidine radical in the 2, 3 or 4 position. The piperidines are said to be



European patent application No. 649838 generically disclosed cyclized amines described by the formula:



DE patent application No. 4410822 generically disclosed cyclized amines described by the formula:

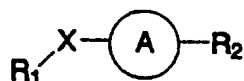
$$R_1-Z-X-N \begin{array}{c} \diagup \quad \diagdown \\ \text{---} \quad \text{---} \\ \diagdown \quad \diagup \end{array} B$$

30 R<sub>4</sub> is H, 1-6C alkyl, or ph, Benzyl, benzoyl,  $\alpha$ -hydroxybenzyl or pyridine.

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The compounds are said to be used in the treatment and therapy of diseases which are relieved by changing the function of the AMPA receptor complex. But there is no disclosure or suggestion of treating disorders responsive to selective NMDA receptor subtype antagonists.

U.S. patent No. 4,942,169 generically disclosed substituted piperidines described by the formula:



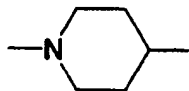
in which

$R_1$  is substituted or unsubstituted Ph or heterocycles;

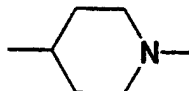
$X$  denotes a group of formula including  $-(CH_2)_n-$ ,  $-O(CH_2)_n-$ ,  $-S(CH_2)_n-$  and  $-NH(CH_2)_n-$ ;

$n$  is 1-7;

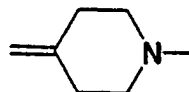
the ring  $A$  denotes a group of the formula



20 or

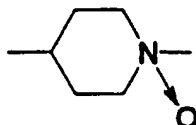


or



or

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R<sub>2</sub> denotes a H, a lower alkyl group, a substituted or unsubstituted benzyl, benzoyl, pyridyl, 2-hydroxyethyl and pyridylmethyl.

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The compounds are said to have antiacetylcholinesterase activities. But there is no disclosure or suggestion of treating disorders responsive to selective NMDA receptor subtype antagonists.

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U.S. Patent No. 5,169,855 generically discloses disubstituted piperidine ether derivatives for use as antipsychotic agents selective for sigma receptors. Similarly, PCT International Publication No.

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WO 92/18127 and PCT International Publication No. WO 91/06297 generically disclose N-phthalimidoalkyl piperidines which are useful as antipsychotic agents and which are selective for sigma receptors. However, the 4-substituted piperidine analogs of this invention are not disclosed by these references and there is no mention of NMDA receptor activity.

20

Numerous references have disclosed additional piperidine derivatives substituted at the 4 and 3 position for use in a variety of treatments. Such references include, for example, U.S. Patent No. 3,255,196 (3 and 4-substituted piperidines that are active antitussives and possess analgesic, antiemetic and local anaesthetic properties); PCT International Publication No. WO 88/02365 (3 and 4-substituted piperidines that may be useful for treatment of mental disorders accompanying cerebrovascular disease); BE 860701 (4-substituted piperidines for use as

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vasodilators and  $\beta$ -adrenergic inhibitors); JP 04-312572 (4-substituted piperidines, such as 4-(4-(N,N-dimethylaminocarbonyl)phenylmethyl)piperidine, for treatment of cerebral ischemia); JP 61-227565 (4 substituted piperidine derivatives for treating diseases requiring the isolation of serotonin); EP 0449186 (4-substituted N-aralkyl piperidines which are selective sigma receptor antagonists for treating physiological or drug induced psychosis or dyskinesia); and DE 2939292 (4-substituted piperidines for use as antiallergenic and antiinflammatory agents). None of these references disclose or suggest the 4-substituted piperidine analogs of the present invention or their use as selective NMDA receptor subtype antagonists.

Excitatory amino acid receptor antagonists that block NMDA receptors are recognized for usefulness in the treatment of disorders. NMDA receptors are intimately involved in the phenomenon of excitotoxicity, which may be a critical determinant of outcome of several neurological disorders. Disorders known to be responsive to blockade of the NMDA receptor include acute cerebral ischemia (stroke or cerebral trauma, for example), muscular spasm, convulsive disorders, neuropathic pain and anxiety, and may be a significant causal factor in chronic neurodegenerative disorders such as Parkinson's disease [T. Klockgether, L. Turski, Ann. Neurol. 34, 585-593 (1993)], human immunodeficiency virus (HIV) related neuronal injury, amyotrophic lateral sclerosis (ALS), Alzheimer's disease [P.T. Francis, N.R. Sims, A.W. Procter, D.M. Bowen, J. Neurochem. 60 (5), 1589-1604 (1993)] and Huntington's disease. [See S. Lipton, TINS 16 (12), 527-532 (1993); S.A. Lipton, P.A. Rosenberg, New Eng. J. Med. 330 (9), 613-622 (1994); and C.F. Bigge, Biochem. Pharmacol. 45, 1547-1561 (1993) and references cited therein.]. NMDA receptor antagonists may also be

- 15 -

used to prevent tolerance to opiate analgesia or to help control withdrawal symptoms from addictive drugs (Eur. Pat. Appl. 488,959A).

5 Expression cloning of the first NMDA receptor subunit, NMDAR1 (NR1) in Nakanishi's lab in 1991 provided an initial view of the molecular structure of the NMDA receptor [Nature 354, 31-37 (1991)]. There are several other structurally related subunits (NMDAR2A through  
10 NMDAR2D) that join NR1 in heteromeric assemblies to form the functional ion channel complex of the receptor [Annu. Rev. Neurosci. 17, 31-108 (1994)]. The molecular heterogeneity of NMDA receptors implies a future potential for agents with subtype selective  
15 pharmacology.

Many of the properties of native NMDA receptors are seen in recombinant homomeric NR1 receptors. These properties are altered by the NR2 subunits.  
20 Recombinant NMDA receptors expressed in Xenopus oocytes have been studied by voltage-clamp recording, as has developmental and regional expression of the mRNAs encoding NMDA receptor subunits. Electrophysiological assays were utilized to characterize the actions of  
25 compounds at NMDA receptors expressed in Xenopus oocytes. The compounds were assayed at four subunit combinations of cloned rat NMDA receptors, corresponding to three putative NMDA receptor subtypes [Moriyoshi, et al. Nature 1991, 354, 31-37; Monyer et  
30 al, Science 1992, 256, 1217-1221; Kutsuwada et al, Nature 1992, 358, 36-41; Sugihara et al, Biochem. Biophys Res. Commun. 1992, 185, 826-832].

An object of this invention is to provide novel 4-  
35 substituted piperidine analogs which function as subtype-selective NMDA receptor antagonists.

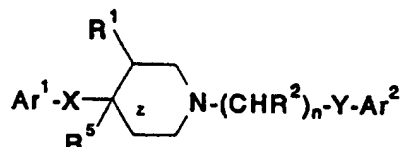
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A further object of this invention is to provide a pharmaceutical composition containing an effective amount of the 4-substituted piperidine analogs to treat cerebrovascular disorders responsive to the selective blockade of NMDA receptor subtypes.

Another object of this invention is to provide a method of treating disorders responsive to the subtype-selective NMDA receptor antagonists in an animal by administering a pharmaceutically effective amount of 4-substituted piperidine analogs.

#### SUMMARY OF THE INVENTION

This invention relates to novel 4-substituted piperidine analogs represented by the formula (I):



I

or a pharmaceutically acceptable salt thereof wherein

Ar¹ and Ar² are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, hydroxy, alkyl, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, amino carbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

z is a single or double bond;

X is  $-(CHR^3)_m-$ , O, S or NR⁴, wherein each R³ is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R⁴ is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or

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2, provided that when z is a double bond then X is not O or NR<sup>4</sup>;

R<sup>1</sup> is hydrogen or hydroxy;

5

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

10

Y is O, S, NR<sup>4</sup> or a single bond; and

R<sup>3</sup> is hydrogen or hydroxy when z is a single bond

- 15 preferably provided that: (i) R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>; (ii) if X is a single bond, z is a double bond or R<sup>3</sup> is hydroxy and Ar<sup>2</sup> is phenyl then Y cannot be O; (iii) if Y is O, n is 3 or 4, R<sup>2</sup> is exclusively hydrogen, z is a single bond, R<sup>1</sup> and R<sup>5</sup> are  
20 hydrogen and Ar<sup>2</sup> is phenyl, or halogen, methoxy, or trifluoromethyl substituted phenyl then X cannot be methylene or ethylene; (iv) if X is -(CHR<sup>3</sup>)<sub>m</sub>-, m is 2 and R<sup>3</sup> is exclusively hydrogen then Ar<sup>1</sup> cannot be imidazolyl substituted; (v) if Y is O, n is 2, 3 or 4,  
25 R<sup>2</sup> is hydrogen or hydroxy, z is a single bond, R<sup>1</sup> and R<sup>3</sup> are hydrogen, and Ar<sup>2</sup> is phenyl, or NO<sub>2</sub>, CN, 1-imidazoyle, or 1,2,4-triazol-1-yl substituted phenyl then X cannot be methylene, hydroxymethylene, or O;  
30 (vi) if Y is O or S, R<sup>1</sup> and R<sup>5</sup> are hydrogen and R<sup>2</sup> is hydroxy then X is not methylene or a single bond; or (vii) if Y is a single bond, R<sup>2</sup> is exclusively hydrogen and Ar<sup>2</sup> is phenyl, then either R<sup>1</sup> or R<sup>5</sup> must be hydroxy.

The compounds of the present invention may exist as  
35 optical isomers and the inventive compounds include both the racemic mixtures of such optical isomers as well as the individual enantiomers.

Examples of pharmaceutically acceptable addition salts include inorganic and organic acid addition salts such as the hydrochloride, hydrobromide, phosphate, sulphate, citrate, lactate, tartrate, maleate,  
5 fumarate, mandelate, oxalate, and the acetate.

Halogen is fluorine, chlorine, bromine, or iodine; fluorine, chlorine, and bromine are preferred groups.

10 Alkyl means a straight or branched chain of from one to six carbon atoms or cyclic alkyl of from three to seven carbon atoms including, but not limited to methyl, ethyl, propyl, isopropyl, butyl, isobutyl, t-butyl, pentyl, hexyl, cyclopropyl, cyclobutyl, cyclopentyl,  
15 and cyclohexyl.

Aryl means a monocyclic or bicyclic carbocyclic aromatic ring system which can be substituted or unsubstituted, for example, but not limited to phenyl,  
20 naphthyl or the like.

Heteroaryl means a monocyclic or bicyclic carbocyclic aromatic ring system substituted by one or more hetero atoms, which can be the same or different, and  
25 includes, for example, thienyl, benzo[b]thienyl, naphtho[2,3-b]thienyl, thianthrenyl, furyl, pyranlyl, isobenzofuranyl, chromenyl, xanthenyl, phenoxanthiinylyl, 2H-pyrrolyl, pyrrolyl, imidazolyl, pyrazolyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, indolizinyl,  
30 isoindolyl, 3H-indolyl, indolyl, indazolyl, purinyl, 4H-quinolizinyl, isoquinolyl, quinolyl, phthalzinylyl, naphthyridinyl, quinoxalinyl, cinnolinyl, pteridinyl, 5aH-carbozolylyl, carbozolylyl, 8-carbolinyl, phenanthridinyl, acridinyl, perimidinyl,  
35 phenanthrolinyl, phenazinyl, isothiazolyl, phenothiazinyl, isoxazolyl, furazanyl, phenoxazinyl, quinoxalinyl, 2,3-dioxoquinoxalinyl, benzimidazolyl,



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2-oxobenzimidazolyl, 2-oxindolyl, 2-thioxobenzimidazole, pyrazolo[3,4-d]pyrimidinyl, 4-hydroxypyrazolo[3,4-d]pyrimidinyl, and 2-methylbenzimidazolyl groups.

5

Aralkyl means any of the alkyl groups defined herein substituted by any of the aryl groups as defined herein.

10 Halogenated alkyl means any of the alkyl groups defined herein substituted by one or more halogens as defined herein.

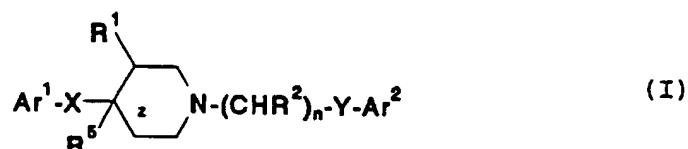
Lower alkyl amino means any of the alkyl groups defined  
15 herein substituted by an amino group.

Lower alkoxy means an alkoxy group containing an alkyl group as defined herein.

20 The instant invention is also related to a pharmaceutical composition containing the compound defined by formula I in an amount effective to treat cerebrovascular disorders responsive to the selective blockade of NMDA receptor subtypes and a  
25 pharmaceutically acceptable carrier. Exemplary disorders responsive to such treatment include cerebral ischemia caused by cerebral trauma, stroke, hypoglycemia, heart attack, and surgery; anxiety-  
psychosis, schizophrenia; glaucoma; CMV retinitis;  
30 aminoglycoside antibiotics-induced hearing loss; urinary incontinence; opioid tolerance or withdrawal; and chronic neurodegenerative disorders such as Huntington's disease, ALS, Parkinsonism and Alzheimer's disease. The pharmaceutical composition of this  
35 invention may also be employed as an analgesic or for the treatment of epilepsy or migraine headaches.

- 20 -

The invention further relates to a method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form at least one compound represented by the formula (I):



or a pharmaceutically acceptable salt thereof wherein

10

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, hydroxy, alkyl, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

15

20

z is a single or double bond;

X is  $-(\text{CHR}^3)_m-$ , O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2, provided that when z is a double bond then X is not O or NR<sup>4</sup>;

25

R<sup>1</sup> is hydrogen or hydroxy;

30

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

35

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Y is O, S, NR<sup>4</sup> or is a single bond; and

R<sup>5</sup> is hydrogen or hydroxy when z is a single bond.

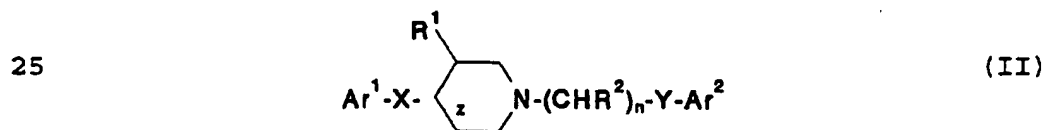
# 5 BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 are bar graphs illustrating the mean infarct volume in the cortex and subcortex after in vivo administration of compounds of this invention to  
10 rodents.

## DETAILED DESCRIPTION OF THE INVENTION

The novel 4-substituted piperidine analogs of this  
15 invention are represented by previously defined formula (I). Generally, Y is O or a single bond. Preferably, R<sup>1</sup> or R<sup>5</sup> is hydroxy. In addition, Ar<sup>2</sup> is preferably a heteroaryl group, e.g., a benzimidazol-2-one, indol-2-one, or a quinoxaline-2,3-dione group.

20 Preferred embodiments of the novel 4-substituted piperidine analogs of this invention are represented by formula (II-XI). In particular, a first embodiment is represented by formula (II) as follows:



or a pharmaceutically acceptable salt thereof wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently the same as previously  
30 defined for formula (I);

z is a single or double bond;

X is -(CHR<sup>3</sup>)<sub>m</sub>-, O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is  
35 independently hydrogen, hydroxy or a lower alkyl group

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having 1 to 6 carbon atoms,  $R^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and  $m$  is 0, 1 or 2, provided that when  $z$  is a double bond then  $X$  is not O or  $NR^4$ ;

5

$R^1$  is hydrogen or hydroxy;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

10

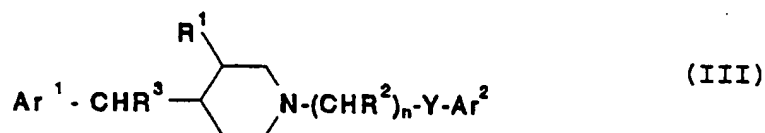
$n$  is 0, 1, 2, 3 or 4; and

$Y$  is O, S,  $NR^4$  or is a single bond, preferably provided that: (i)  $R^2$  cannot be hydroxy in a position alpha to  $Ar^2$ ; (ii) if  $X$  is a single bond,  $z$  is a double bond and  $Ar^2$  is phenyl then  $Y$  cannot be O; (iii) if  $Y$  is O,  $n$  is 3 or 4,  $R^2$  is exclusively hydrogen,  $R^1$  is hydrogen and  $Ar^2$  is phenyl, or halogen, methoxy, or trifluoromethyl substituted phenyl then  $X$  cannot be methylene or ethylene; (iv) if  $X$  is  $-(CHR^3)_m-$ ,  $m$  is 2 and  $R^3$  is exclusively hydrogen then  $Ar^1$  cannot be imidazolyl substituted; (v) if  $Y$  is O,  $n$  is 2, 3 or 4,  $R^2$  is hydrogen or hydroxy,  $R^1$  is hydrogen and  $Ar^2$  is phenyl, or  $NO_2$ , CN, 1-imidazolyl, or 1,2,4-triazol-1-yl substituted phenyl then  $X$  cannot be methylene, hydroxymethylene, or O; (vi) if  $Y$  is O or S,  $R^1$  is hydrogen and  $R^2$  is hydroxy then  $X$  is not methylene or a single bond; or (vii) if  $Y$  is a single bond,  $R^2$  is exclusively hydrogen and  $Ar^2$  is phenyl then  $R^1$  must be hydroxy.

30

Another embodiment of the novel 4-substituted piperidines of this invention is represented by formula (III) as follows:

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or a pharmaceutically acceptable salt thereof wherein;

5 Ar<sup>1</sup> and Ar<sup>2</sup> are independently the same as described for formula (I);

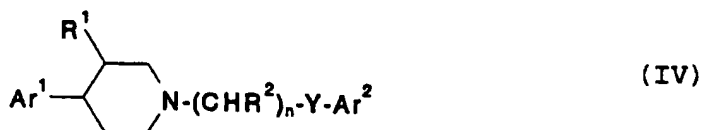
R<sup>1</sup> is hydrogen or hydroxy;

10 each R<sup>2</sup> and R<sup>3</sup> are independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and

15 Y is O, S, NR<sup>4</sup> or is a single bond, preferably provided that: (i) R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>; (ii) if Y is O, n is 3 or 4, R<sup>2</sup> is exclusively hydrogen, R<sup>1</sup> is hydrogen and Ar<sup>2</sup> is phenyl, or halogen, methoxy or trifluoromethyl substituted phenyl then X  
20 cannot be methylene or ethylene; (iii) if Y is O, n is 2, 3 or 4, R<sup>2</sup> is hydrogen or hydroxy, R<sup>1</sup> is hydrogen and Ar<sup>2</sup> is phenyl, or NO<sub>2</sub>, CN, 1-imidazolyl, or 1,2,4-triazol-1-yl substituted phenyl then R<sup>3</sup> cannot be hydrogen; (iv) if Y is O or S, R<sup>1</sup> is hydrogen and R<sup>2</sup> is  
25 hydroxy then R<sup>3</sup> cannot be hydrogen; or (v) if Y is a single bond, R<sup>2</sup> is exclusively hydrogen and Ar<sup>2</sup> is phenyl then R<sup>1</sup> must be hydroxy.

An additional embodiment of the novel 4-substituted  
30 piperidines of this invention is represented by formula (IV) as follows:



or a pharmaceutically acceptable salt thereof,

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Ar<sup>1</sup> and Ar<sup>2</sup> are independently the same as described for formula (I);

R<sup>1</sup> is hydrogen or hydroxy;

5

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

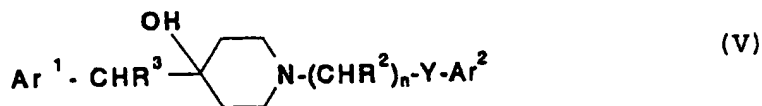
n is 1, 2, 3 or 4; and

10

Y is O, S, NR<sup>4</sup> or is a single bond, preferably provided that: (i) R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>; or (ii) if Y is a single bond, O or S then R<sup>2</sup> is not hydroxy.

15

Yet another embodiment of the invention is represented by the formula (V):



20 or a pharmaceutically acceptable salt thereof wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently the same as described for formula (I);

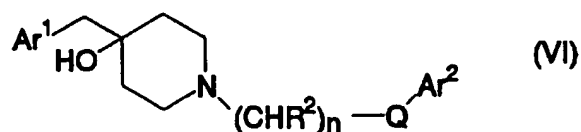
25 each R<sup>2</sup> and R<sup>3</sup> are independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and

30 Y is O, S, NR<sup>4</sup> or is a single bond, preferably provided that R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>.

Yet another embodiment of the invention is represented by the formula (VI):

- 25 -



or a pharmaceutically acceptable salt thereof wherein:

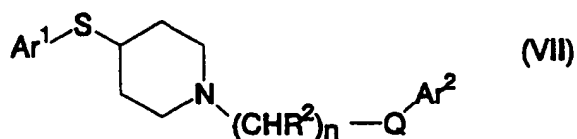
Ar¹ and Ar² are independently the same as described for  
5 formula (I);

each R² is independently hydrogen, hydroxy or a lower  
alkyl group having 1 to 6 carbon atoms;

10 n is 0, 1, 2, 3 or 4;

Q is O, S, NR⁴ or is a single bond.

Yet another embodiment of the invention is represented  
15 by the formula (VII):



or a pharmaceutically acceptable salt thereof wherein:

20 Ar¹ and Ar² are independently the same as described for  
formula (I);

each R² is independently hydrogen, hydroxy or a lower  
alkyl group having 1 to 6 carbon atoms;

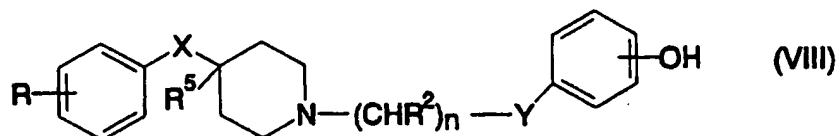
25

n is 0, 1, 2, 3 or 4; and

Q is O, S, NR⁴ or is a single bond.

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Yet another embodiment of the invention is represented by the formula (VIII):



or a pharmaceutically acceptable salt thereof wherein:

5

$n$  is 0, 1, 2, 3 or 4;

$R^5$  is hydrogen or hydroxy;

- 10  $R$  is hydrogen, hydroxy, alkyl, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl  
 15 group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

20

$X$  is  $-(CH(R^3))_m O$ , S or  $NR^4$ ;

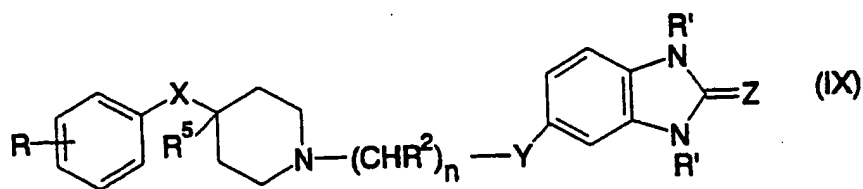
$Y$  is O, S,  $NR^4$  or is a single bond;

- 25  $R^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $R^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and  $m$  is 0, 1 or 2; and

- 30  $R^5$  is hydrogen or hydroxy.

Yet another embodiment of the invention is represented by the formula (IX):





or a pharmaceutically acceptable salt thereof wherein:

5 n is 0, 1, 2, 3 or 4;

R<sup>3</sup> is hydrogen or hydroxy;

R is hydrogen, hydroxy, alkyl, halogen, nitro, cyano,  
 10 carboxaldehyde, aldehyde oxime, lower alkoxy  
 carbonylmethyl, hydroxy lower alkyl,  
 aminocarbonylmethyl, hydrazinocarbonylmethyl,  
 acetamido, aryl, aralkyl, amino, a halogenated alkyl  
 group, a lower alkyl amino group or a lower alkoxy  
 15 group;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower  
 alkyl group having 1 to 6 carbon atoms;

20 Y is O, S, NR<sup>4</sup> or is a single bond;

Z is O or S.

R<sup>5</sup> is hydrogen or hydroxy;

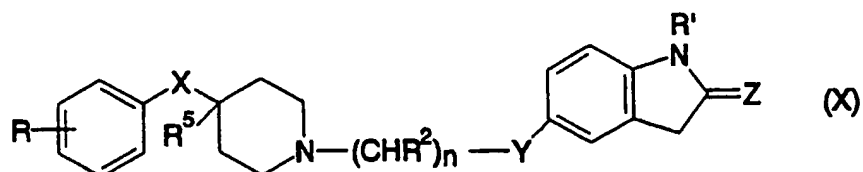
25

X is  $-(CHR^3)_m$ , O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is  
 independently hydrogen, hydroxy or a lower alkyl group  
 having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower  
 alkyl group having 1 to 6 carbon atoms and m is 0, 1 or  
 30 2; and

R' is independently hydrogen or alkyl.

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Yet another embodiment of the invention is represented by the formula (X):



5 or a pharmaceutically acceptable salt thereof wherein:

n is 0, 1, 2, 3 or 4;

R<sup>5</sup> is hydrogen or hydroxy;

10

R is hydrogen, hydroxy, alkyl, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl,

15 acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower

20 alkyl group having 1 to 6 carbon atoms;

Y is O, S, NR<sup>4</sup> or is a single bond;

Z is O or S;

25

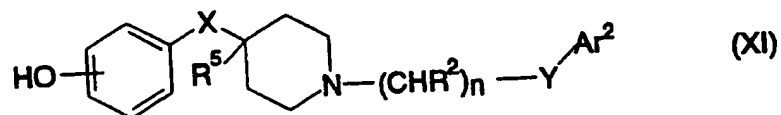
X is -(CHR<sup>3</sup>)<sub>m</sub>-, O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or

30 2;

R<sup>5</sup> is hydrogen or hydroxy; and

R' is hydrogen or alkyl.

Yet another embodiment of the invention is represented by the formula (XI):



5 or a pharmaceutically acceptable salt thereof wherein:

n is 0, 1, 2, 3 or 4;

10 Ar<sup>2</sup> is the same as previously defined for formula (I);

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

15 X is -(CHR<sup>3</sup>)<sub>m</sub>-, O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2;

20 Y is O, S, NR<sup>4</sup> or is a single bond; and

R<sup>5</sup> is hydrogen or hydroxy.

25 Exemplary preferred compounds of formula I include, without limitation:

4-Phenoxy-1-[(4-fluorophenoxy)propyl]piperidine;

30 1-(3-Phenoxypropyl)-4-phenylpiperidine;

- 1- (2-Phenoxyethyl) -4-phenylpiperidine;
- 1- (4-Phenoxybutyl) -4-phenylpiperidine;
- 5 1- (4- (3- (Trifluoromethyl) phenoxy) butyl) -4-phenylpiperidine;
- 1- (2- (4-Aminophenoxy) ethyl) -4-benzylpiperidine;
- 10 3- ( (2- (4-Benzylpiperidin-1-yl) ethyl) oxy) benzaldehyde;
- 3- ( (2- (4-Benzylpiperidin-1-yl) ethyl) oxy) benzaldehyde oxime;
- 15 4-Benzyl-1- (2- (3- (ethoxycarbonylmethyl) -phenoxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (3- (2-hydroxyethyl) phenoxy) ethyl) piperidine;
- 20 1- (2- (3- (Aminocarbonylmethyl) phenoxy) ethyl) -4-benzylpiperidine;
- 4-Benzyl-1- (2- (3- (hydrazinocarbonylmethyl) -phenoxy) ethyl) piperidine;
- 25 4-Benzyl-1- (1-methyl-2-phenoxyethyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (2- (4-fluorophenoxy) -ethyl) piperidine;
- 30 4- (4-Chlorobenzyl) -1- (2- (4-chlorophenoxyethyl) -piperidine;
- 35 1- (2- (4-Aminophenoxy) ethyl) -4- (4-chlorobenzyl) -piperidine;

- 4 - (4-Chlorobenzyl) - 1 - (2 - (3 - (2-hydroxyethyl)phenoxy) -  
ethyl)piperidine;
- 4 - (4-Fluorobenzyl) - 1 - (2 - (4-fluorophenoxy)ethyl) -  
5 piperidine;
- 4 - (4-Fluorobenzyl) - 1 - (2 - (4-chlorophenoxy) -  
ethyl)piperidine;
- 10 1 - (2 - (4-Fluorophenoxy)ethyl) - 4 - (4-methoxybenzyl) -  
piperidine;
- 1 - (2 - (4-Fluorophenoxy)ethyl) - 4 - (4-nitrobenzyl) -  
piperidine;
- 15 4-Benzyl-1 - (1-methyl-3-phenoxypropyl)piperidine;
- 1 - (2-Phenoxyethyl) - 4-phenylpiperidine;
- 20 3-Hydroxy-1 - (2-phenoxyethyl) - 4 - (3-  
trifluoromethylphenyl)piperidine;
- 3-Hydroxy-1 - (3-phenoxypropyl) - 4 - (3-  
trifluoromethylphenyl)piperidine;
- 25 4-Benzyl-1 - [2 - (6-quinolinoxy)ethyl]piperidine;
- 4-Benzyl-1 - [2 - (8-quinolinoxy)ethyl]piperidine;
- 30 4-Benzyl-1 - [2 - (2-amino-3-nitrophenoxy)ethyl] -  
piperidine;
- 4-Benzyl-1 - [2 - (2,3-diaminophenoxy)ethyl] - piperidine;
- 35 4-Benzyl-1 - [2 - (2,3-dioxoquinoxalin-5-oxo) -  
ethyl]piperidine;

- 4-Benzyl-1-[2-(2-oxobenzimidazol-4-oxy)-ethyl]piperidine;
- 5 4-Benzyl-1-[2-(4-amino-3-nitrophenoxy)-ethyl]piperidine;
- 4-Benzyl-1-[2-(3,4-diaminophenoxy)ethyl]piperidine;
- 10 4-Benzyl-1-[2-(2,3-dioxoquinoxalin-6-oxy)-ethyl]piperidine;
- 4-Benzyl-1-[2-(2-oxobenzimidazol-5-oxy)-ethyl]piperidine;
- 15 4-Benzyl-1-[2-(2-aminophenoxy)ethyl]piperidine;
- 4-Benzyl-1-[2-(3-aminophenoxy)ethyl]piperidine;
- 4-Benzyl-1-[2-(4-aminophenoxy)ethyl]piperidine;
- 20 4-[2-(4-Benzylpiperidinoethoxy)quinazoline;
- 4-[2-(4-Benzylpiperidino)ethoxy]pyrazolo-[3,4-d]pyrimidine;
- 25 1-[2-(4-Benzylpiperidino)ethyl]-4-hydroxypyrazolo[3,4-d]pyrimidine;
- 4-Benzyl-1-[2-(2-methoxyphenoxy)ethyl]piperidine;
- 30 4-Benzyl-1-[2-(3-methoxyphenoxy)ethyl]piperidine;
- 4-Benzyl-1-[2-(4-methoxyphenoxy)ethyl]piperidine;
- 35 4-Benzyl-1-[2-(3,4-bisacetamidophenoxy)ethyl]-piperidine;

4-Benzyl-1-[2-(2-methylbenzimidazol-6-oxy)ethyl]piperidine;

5 4-Benzyl-1-[2-(2-methylbenzimidazol-5-oxy)ethyl]piperidine;

4-Benzyl-1-[2-(3-trifluoromethylphenoxy)ethyl]piperidine;

10 4-(4-Chlorobenzyl)-1-[2-(2-nitrophenoxy)ethyl]piperidine;

4-(4-Chlorobenzyl)-1-[2-(2-aminophenoxy)ethyl]piperidine;

15 4-(4-Chlorobenzyl)-1-[2-(2-amino-3-nitrophenoxy)ethyl]piperidine;

20 4-(4-Chlorobenzyl)-1-[2-(2,3-diaminophenoxy)ethyl]piperidine;

4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-4-oxy)ethyl]piperidine;

25 4-(4-Chlorobenzyl)-1-[2-(4-amino-3-nitrophenoxy)ethyl]piperidine;

4-(4-Chlorobenzyl)-1-[2-(3,4-diaminophenoxy)ethyl]piperidine;

30 4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine;

35 4-(4-Fluorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine;

- 4- (4-Chlorophenyl) -4-hydroxy-1- (3-phenylpropyl) -  
piperidine;
- 4- (4-Chlorophenyl) -4-hydroxy-1- (4-phenylbutyl) -  
5 piperidine;
- 3-Hydroxy-1- (4-phenylbutyl) -4- (3-  
trifluoromethylphenyl) - piperidine;
- 10 4-Benzyl-4-hydroxy-1- (2-phenylethyl) piperidine;
- 1,4-Dibenzyl-4-hydroxypiperidine;
- 1-Benzyl-4- (4-fluorobenzyl) -4-hydroxypiperidine;
- 15 4- (4-Fluorobenzyl) -1- [2- (4-fluorophenyl) ethyl] -4-  
hydroxypiperidine;
- 4- (2-Keto-1-benzimidazoliny) -1- (3-phenoxypropyl) -  
20 piperidine;
- 4-Benzyl-4-hydroxy-1- (2-phenoxyethyl) piperidine;
- 4-Benzyl-4-hydroxy-1- (3-phenylpropyl) piperidine;
- 25 4-Benzyl-4-hydroxy-1- (3-phenoxypropyl) piperidine;
- 4-Benzyl-1- [ (2-hydroxy-4-phenyl) butyl] piperidine;
- 30 3-Hydroxy-4- (3-trifluoromethylphenyl) -1- [3- (3-  
aminophenoxy) propyl] piperidine;
- 3-Hydroxy-4- (4-fluorophenyl) -1- [3- (3-amino-1-  
naphthyloxy) propyl] piperidine;
- 35 4-Benzyl-1- (2- (4-hydroxyphenoxy) ethyl) piperidine;



- 4 - (4-Chlorobenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 5 4 - (4-Fluorobenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4 - (4-Hydroxybenzyl) - 1 - (2 - (4-fluorophenoxy) ethyl) piperidine;
- 10 4 - Benzyl - 1 - (3 - (4-hydroxyphenyl) propyl) piperidine;
- 4 - (4-Chlorobenzyl) - 1 - (3 - (4-hydroxyphenyl) propyl) piperidine;
- 15 4 - Benzyl - 1 - (2 - (4-hydroxyphenyl) ethyl) piperidine;
- 4 - (3-Fluorobenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 20 4 - (3-Fluorobenzyl) - 1 - (2 - (4-fluorophenoxy) ethyl) piperidine;
- 4 - (4-Methylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 25 4 - (4-Ethylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4 - (4-Methoxybenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 30 4 - (3,4-Difluorobenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 35 4 - (4-Fluorobenzyl) - 4-hydroxy - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;

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- 4- (2-Fluorobenzyl) -1- (2- (4-  
hydroxyphenoxy) ethyl) piperidine;
- 4- (4-Trifluoromethylbenzyl) -1- (2- (4-  
5 hydroxyphenoxy) ethyl) piperidine;
- 4- (4-Isopropylbenzyl) -1- (2- (4-  
hydroxyphenoxy) ethyl) piperidine;
- 10 4- (4-t-Butylbenzyl) -1- (2- (4-  
hydroxyphenoxy) ethyl) piperidine;
- 4- (2-Fluoro-4-methylbenzyl) -1- (2- (4-  
hydroxyphenoxy) ethyl) piperidine;
- 15 4- ((5,6,7,8-Tetrahydro-2-naphthyl)methyl) -1- (2- (4-  
hydroxyphenoxy) ethyl) piperidine;
- 4- ((2-Naphthyl)methyl) -1- (2- (4-  
20 hydroxyphenoxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (N-methylanilino) ethyl) piperidine;
- 4-Benzyl-1- (2- (thiophenoxy) ethyl) piperidine;
- 25 4- (4-Chlorobenzyl) -1- (2- (2-chloro-4- (2-  
hydroxyethyl) phenoxy) ethyl) piperidine;
- 4- (2,6-Difluorobenzyl) -1- (2- (4-  
30 hydroxyphenoxy) ethyl) piperidine;
- 4- (2-Fluoro-4-methylbenzyl) -1- (2- (4-hydroxy-3-  
methylphenoxy) ethyl) piperidine;
- 35 4-Benzyl-1- (2- (3,4-  
methylenedioxyphenoxy) ethyl) piperidine;

- 4- (2-Fluoro-4-methylbenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;
- 4- (4-Fluorobenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;
- 5 4- (4-Methylbenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;
- 10 4- (4-Fluorobenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;
- 4- (4-Methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;
- 15 4-Hydroxy-4- (4-methylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;
- 4-Hydroxy-4- (4-methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;
- 20 4-Benzyl-1- (2- (2-hydroxyphenoxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (3-hydroxyphenoxy) ethyl) piperidine;
- 25 4- (4-Fluorobenzyl) -1- (2- (2-hydroxyphenoxy) ethyl) piperidine;
- 4- (4-Fluorobenzyl) -1- (2- (3-hydroxyphenoxy) ethyl) piperidine;
- 30 4- (4-Methylbenzyl) -1- (2- (2-hydroxyphenoxy) ethyl) piperidine;
- 4- (4-Methylbenzyl) -1- (2- (3-hydroxyphenoxy) ethyl) piperidine;
- 35

- 4-Benzyl-1-(2-(N-methyl-4-hydroxyanilino)ethyl)piperidine;
- 5 4-Benzyl-4-hydroxy-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 4-(4-Fluorobenzyl)-1-(2-(4-hydroxythiophenoxy)ethyl)piperidine;
- 10 4-(4-Hydroxyphenyl)-1-(4-phenylbutyl)piperidine;
- 4-Benzyl-1-(3-(2-oxobenzimidazol-5-oxy)propyl)piperidine;
- 15 4-Benzyl-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;
- 4-Benzyl-1-(2-(2-iminobenzimidazol-5-oxy)ethyl)piperidine;
- 20 4-(4-Methylbenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;
- 4-(4-Fluorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;
- 25 4-(4-Chlorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;
- 30 4-Benzyl-1-(2-(2-oxobenzoxazol-5-oxy)ethyl)piperidine;
- 4-Benzyl-1-(2-(2-oxobenzoxazol-6-oxy)ethyl)piperidine;
- 4-Benzyl-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine;
- 35 4-Benzyl-1-(2-(3-hydroxynaphth-6-oxy)ethyl)piperidine;

- 4 - (4-Fluorobenzyl) - 1 - (2 - (2-hydroxynaphth-6-oxy) ethyl) piperidine;
- 4 - (4-Methylbenzyl) - 1 - (2 - (2-hydroxynaphth-6-oxy) ethyl) piperidine;
- 5 4 - Benzyl - 1 - (2 - (3-methyl-2-oxobenzimidazol-5-oxy) ethyl) piperidine;
- 10 4 - Benzyl - 1 - (2 - (2-oxo-1,3-dihydroindol-5-oxy) ethyl) piperidine;
- 4 - (4-Fluorobenzyl) - 1 - (2 - (2-oxo-1,3-dihydroindol-5-oxy) ethyl) piperidine; and
- 15 pharmaceutically acceptable salts thereof.

The invention is also directed to a method for treating disorders responsive to the selective blockade of NMDA receptor subtypes in animals suffering thereof.

20 Particular preferred embodiments of the 4-substituted piperidine analogs for use in the method of this invention are represented by previously defined formulae (II-XI).

25 Exemplary preferred selective NMDA receptor subtype antagonist compounds that may be employed in the method of this invention include, without limitation:

- 30 1 - (2-Phenoxyethyl) - 4-phenylpiperidine;
- 1 - (4 - (3 - (Trifluoromethyl) phenoxy) butyl) - 4-phenylpiperidine;
- 35 4 - Benzyl - 1 - (2 - (4-chlorophenoxy) ethyl) piperidine;
- 4 - Benzyl - 1 - (2 - (4-nitrophenoxy) ethyl) piperidine;

- 1- (2- (4-Aminophenoxy) ethyl) -4-benzylpiperidine;
- 4-Benzyl-1- (2- (4-cyanophenoxy) ethyl) piperidine;
- 5 3- ((2- (4-Benzylpiperidin-1-yl) ethyl) oxy) benzaldehyde;
- 3- ((2- (4-Benzylpiperidin-1-yl) ethyl) oxy) benzaldehyde  
oxime;
- 10 4-Benzyl-1- (2- (3- (ethoxycarbonylmethyl) -  
phenoxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (3- (2-hydroxyethyl) phenoxy) -  
ethyl) piperidine;
- 15 1- (2- (3- (Aminocarbonylmethyl) phenoxy) ethyl) -4-  
benzylpiperidine;
- 4-Benzyl-1- (2- (3- (hydrazinocarbonylmethyl) phenoxy) -  
20 ethyl) piperidine;
- 4-Benzyl-1- (1-methyl-2-phenoxyethyl) piperidine;
- 4-Benzyl-1- (3- (3-fluorophenoxy) propyl) piperidine;
- 25 4-Benzyl-1- (4- (3-fluorophenoxy) butyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (2-phenoxyethyl) piperidine;
- 30 4- (4-Chlorobenzyl) -1- (2- (4-fluorophenoxy) -  
ethyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (2- (4-chlorophenoxyethyl) -  
piperidine;
- 35 4- (4-Chlorobenzyl) -1- (2- (4-nitrophenoxy) -  
ethyl) piperidine;

- 1- (2- (4-Aminophenoxy) ethyl) -4- (4-chlorobenzyl) -  
piperidine;
- 4- (4-Chlorobenzyl) -1- (2- (3- (2-hydroxyethyl) phenoxy) -  
5 ethyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (3-phenoxypropyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (3- (3-fluorophenoxy) -  
10 propyl) piperidine;
- 4- (4-Fluorobenzyl) -1- (2- (4-fluorophenoxy) ethyl) -  
piperidine;
- 15 4- (4-Fluorobenzyl) -1- (2- (4-chlorophenoxy) -  
ethyl) piperidine;
- 1- (2- (4-Fluorophenoxy) ethyl) -4- (4-methoxybenzyl) -  
piperidine;
- 20 1- (2- (4-Fluorophenoxy) ethyl) -4- (4-nitrobenzyl) -  
piperidine;
- 4- (4-Nitrobenzyl) -1- (3-phenoxypropyl) piperidine;
- 25 4-Benzyl-1- (1-methyl-3-phenoxypropyl) piperidine;
- 4- (4-Chlorophenyl) -4-hydroxy-1- (2-phenoxyethyl) -  
piperidine;
- 30 1- (2-Phenoxyethyl) -4-phenylpiperidine;
- 4- (4-Chlorophenyl) -4-hydroxy-1- (3-  
phenoxypropyl) piperidine;
- 35 3-Hydroxy-1- (2-phenoxyethyl) -4- (3-trifluoromethyl-  
phenyl) piperidine;

3-Hydroxy-1-(3-phenoxypropyl)-4-(3-trifluoromethyl-phenyl)piperidine;

4-Benzyl-1-[2-(6-quinolinoxy)ethyl]piperidine;

5

4-Benzyl-1-[2-(8-quinolinoxy)ethyl]piperidine;

4-Benzyl-1-[2-(2-amino-3-nitrophenoxy)ethyl]-piperidine;

10

4-Benzyl-1-[2-(2,3-diaminophenoxy)ethyl]piperidine;

4-Benzyl-1-[2-(2,3-dioxoquinoxalin-5-oxy)-ethyl]piperidine;

15

4-Benzyl-1-[2-(2-oxobenzimidazol-4-oxy)-ethyl]piperidine;

4-Benzyl-1-[2-(4-amino-3-nitrophenoxy)-ethyl]piperidine;

20

4-Benzyl-1-[2-(3,4-diaminophenoxy)ethyl]piperidine;

4-Benzyl-1-[2-(2,3-dioxoquinoxalin-6-oxy)ethyl]-

25 piperidine;

4-Benzyl-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]-piperidine;

30 4-Benzyl-1-[2-(2-nitrophenoxy)ethyl]piperidine;

4-Benzyl-1-[2-(2-aminophenoxy)ethyl]piperidine;

4-Benzyl-1-[2-(3-nitrophenoxy)ethyl]piperidine;

35

4-Benzyl-1-[2-(3-aminophenoxy)ethyl]piperidine;



- 4-Benzyl-1-[2-(4-nitrophenoxy)ethyl]piperidine;
- 4-Benzyl-1-[2-(4-aminophenoxy)ethyl]piperidine;
- 5 4-[2-(4-Benzylpiperidinoethoxy)quinazoline;
- 4-[2-(4-Benzylpiperidino)ethoxy]pyrazolo-[3,4-  
d]pyrimidine;
- 10 1-[2-(4-Benzylpiperidino)ethyl]-4-hydroxypyrazolo[3,4-  
d]pyrimidine;
- 4-Benzyl-1-[2-(2-methoxyphenoxy)ethyl]piperidine;
- 15 4-Benzyl-1-[2-(3-methoxyphenoxy)ethyl]piperidine;
- 4-Benzyl-1-[2-(4-methoxyphenoxy)ethyl]piperidine;
- 20 4-Benzyl-1-[2-(3,4-bisacetamidophenoxy)ethyl]-  
piperidine;
- 4-Benzyl-1-[2-(2-methylbenzimidazol-6-oxy)ethyl]-  
piperidine;
- 25 4-Benzyl-1-[2-(2-methylbenzimidazol-5-oxy)ethyl]-  
piperidine;
- 4-Benzyl-1-[2-(3-trifluoromethylphenoxy)-  
ethyl]piperidine;
- 30 4-(4-Chlorobenzyl)-1-[2-(2-nitrophenoxy)-  
ethyl]piperidine;
- 4-(4-Chlorobenzyl)-1-[2-(2-aminophenoxy)-  
ethyl]piperidine;
- 35

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- 4-(4-Chlorobenzyl)-1-[2-(2-amino-3-nitrophenoxy)-ethyl]piperidine;
- 4-(4-Chlorobenzyl)-1-[2-(2,3-diaminophenoxy)-ethyl]piperidine;
- 5
- 4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-4-oxy)ethyl]-piperidine;
- 10 4-(4-Chlorobenzyl)-1-[2-(4-amino-3-nitrophenoxy)ethyl]-piperidine;
- 4-(4-Chlorobenzyl)-1-[2-(3,4-diaminophenoxy)ethyl]-piperidine;
- 15
- 4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]-piperidine;
- 4-(4-Fluorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]-piperidine;
- 20
- 4-Benzyl-1-(2-phenylethyl)piperidine;
- 1,4-Dibenzylpiperidine;
- 25
- 4-(4-Chlorophenyl)-4-hydroxy-1-(3-phenylpropyl)-piperidine;
- 4-(4-Chlorophenyl)-4-hydroxy-1-(4-phenylbutyl)-piperidine;
- 30
- 3-Hydroxy-1-(4-phenylbutyl)-4-(3-trifluoromethylphenyl)-piperidine;
- 35 4-Benzyl-4-hydroxy-1-(2-phenylethyl)piperidine;
- 1,4-Dibenzyl-4-hydroxypiperidine;

- 1-Benzyl-4-(4-fluorobenzyl)-4-hydroxypiperidine;
- 4-(4-Fluorobenzyl)-1-[2-(4-fluorophenyl)ethyl]-4-hydroxypiperidine;
- 5 4-(2-Keto-1-benzimidazoliny)-1-(3-phenoxypropyl)-piperidine;
- 4-Benzyl-1-(2-phenoxyethyl)piperidine;
- 10 4-Benzyl-1-(3-phenoxypropyl)piperidine;
- 4-Benzyl-1-(3-phenylpropyl)piperidine;
- 15 4-Benzyl-4-hydroxy-1-(2-phenoxyethyl)piperidine;
- 4-Benzyl-1-[2-hydroxy-3-(1-naphthyloxy)propyl]-piperidine;
- 20 4-Benzyl-4-hydroxy-1-(3-phenylpropyl)piperidine;
- 4-Benzyl-4-hydroxy-1-(3-phenoxypropyl)piperidine;
- 4-Benzyl-1-[(2-hydroxy-4-phenyl)butyl]piperidine;
- 25 1-(3-Phenoxypropyl)-4-phenylpiperidine;
- 1-(4-Phenoxybutyl)-4-phenylpiperidine;
- 30 4-Phenoxy-1-[3-(4-fluorophenoxy)propyl]piperidine;
- 4-(2-Methoxyphenoxy)-1-(4-phenylbutyl)piperidine;
- 4-Benzyl-1-(4-phenylbutyl)piperidine;
- 35 4-[(3-Trifluoromethylphenyl)methyl]-1-[2-(3-aminophenoxy)ethyl]piperidine;

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- 4-[(3-Trifluoromethylphenyl)methyl]-1-[3-(3-aminophenoxy)propyl]piperidine;
- 3-Hydroxy-4-(3-trifluoromethylphenyl)-1-[3-(3-aminophenoxy)propyl]piperidine;
- 5 3-Hydroxy-4-(4-fluorophenyl)-1-[3-(3-amino-1-naphthyloxy)propyl]piperidine;
- 10 4-Benzyl-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 4-(4-Chlorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 15 4-(4-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 4-(4-Hydroxybenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine;
- 20 4-Benzyl-1-(3-(4-hydroxyphenyl)propyl)piperidine;
- 4-(4-Chlorobenzyl)-1-(3-(4-hydroxyphenyl)propyl)piperidine;
- 25 4-Benzyl-1-(2-(4-hydroxyphenyl)ethyl)piperidine;
- 4-(3-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 30 4-(3-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine;
- 4-(4-Methylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 35

- 4 - (4-Ethylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 5 4 - (4-Methoxybenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4 - (3,4-Difluorobenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 10 4 - (4-Fluorobenzyl) - 4-hydroxy-1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4 - (2-Fluorobenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 15 4 - (4-Trifluoromethylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4 - (4-Isopropylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 20 4 - (4-t-Butylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4 - (2-Fluoro-4-methylbenzyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 25 4 - ((5,6,7,8-Tetrahydro-2-naphthyl)methyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 30 4 - ((2-Naphthyl)methyl) - 1 - (2 - (4-hydroxyphenoxy) ethyl) piperidine;
- 4-Benzyl-1 - (2 - (N-methylanilino) ethyl) piperidine;
- 35 4-Benzyl-1 - (2 - (thiophenoxy) ethyl) piperidine;

- 4-(4-Chlorobenzyl)-1-(2-(2-chloro-4-(2-hydroxyethyl)phenoxy)ethyl)piperidine;
- 4-(2,6-Difluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 5 4-(2-Fluoro-4-methylbenzyl)-1-(2-(4-hydroxy-3-methylphenoxy)ethyl)piperidine;
- 10 4-Benzyl-1-(2-(3,4-methylenedioxyphenoxy)ethyl)piperidine;
- 4-(2-Fluoro-4-methylbenzyl)-1-(2-(3-fluoro-4-hydroxyphenoxy)ethyl)piperidine;
- 15 4-(4-Fluorobenzyl)-1-(2-(3-fluoro-4-hydroxyphenoxy)ethyl)piperidine;
- 4-(4-Methylbenzyl)-1-(2-(3-fluoro-4-hydroxyphenoxy)ethyl)piperidine;
- 20 4-(4-Fluorobenzyl)-1-(2-(4-hydroxy-3-methylphenoxy)ethyl)piperidine;
- 25 4-(4-Methylbenzyl)-1-(2-(4-hydroxy-3-methylphenoxy)ethyl)piperidine;
- 4-Hydroxy-4-(4-methylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 30 4-Hydroxy-4-(4-methylbenzyl)-1-(2-(4-hydroxy-3-methylphenoxy)ethyl)piperidine;
- 4-Benzyl-1-(2-(2-hydroxyphenoxy)ethyl)piperidine;
- 35 4-Benzyl-1-(2-(3-hydroxyphenoxy)ethyl)piperidine;

- 4-(4-Fluorobenzyl)-1-(2-(2-hydroxyphenoxy)ethyl)piperidine;
- 5 4-(4-Fluorobenzyl)-1-(2-(3-hydroxyphenoxy)ethyl)piperidine;
- 4-(4-Methylbenzyl)-1-(2-(2-hydroxyphenoxy)ethyl)piperidine;
- 10 4-(4-Methylbenzyl)-1-(2-(3-hydroxyphenoxy)ethyl)piperidine;
- 4-Benzyl-1-(2-(N-methyl-4-hydroxyanilino)ethyl)piperidine;
- 15 4-Benzyl-4-hydroxy-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;
- 4-(4-Fluorobenzyl)-1-(2-(4-hydroxythiophenoxy)ethyl)piperidine;
- 20 4-(4-Hydroxyphenyl)-1-(4-phenylbutyl)piperidine;
- 4-Benzyl-1-(3-(2-oxobenzimidazol-5-oxy)propyl)piperidine;
- 25 4-Benzyl-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;
- 30 4-Benzyl-1-(2-(2-iminobenzimidazol-5-oxy)ethyl)piperidine;
- 4-(4-Methylbenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;
- 35 4-(4-Fluorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;

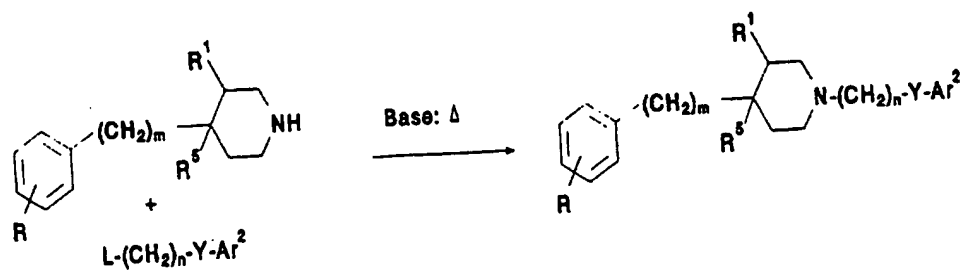
- 4- (4-Chlorobenzyl) -1- (2- (2-thioxobenzimidazol-5-oxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (2-oxobenzoxazol-5-oxy) ethyl) piperidine;
- 5 4-Benzyl-1- (2- (2-oxobenzoxazol-6-oxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (2-hydroxynaphth-6-oxy) ethyl) piperidine;
- 10 4-Benzyl-1- (2- (3-hydroxynaphth-6-oxy) ethyl) piperidine;
- 4- (4-Fluorobenzyl) -1- (2- (2-hydroxynaphth-6-oxy) ethyl) piperidine;
- 15 4- (4-Methylbenzyl) -1- (2- (2-hydroxynaphth-6-oxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (3-methyl-2-oxobenzimidazol-5-oxy) ethyl) piperidine;
- 20 4-Benzyl-1- (2- (2-oxo-1,3-dihydroindol-5-oxy) ethyl) piperidine;
- 4- (4-Fluorobenzyl) -1- (2- (2-oxo-1,3-dihydroindol-5-oxy) ethyl) piperidine; and
- 25

pharmaceutically acceptable salts thereof.

- The compounds of this invention may be prepared using
- 30 methods well known to those skilled in the art.
- Exemplary reaction schemes I, II, and III illustrate methods for preparing the compounds of this invention.
- The starting materials employed in Schemes I, II and III are readily available or can be prepared by known
- 35 methods.



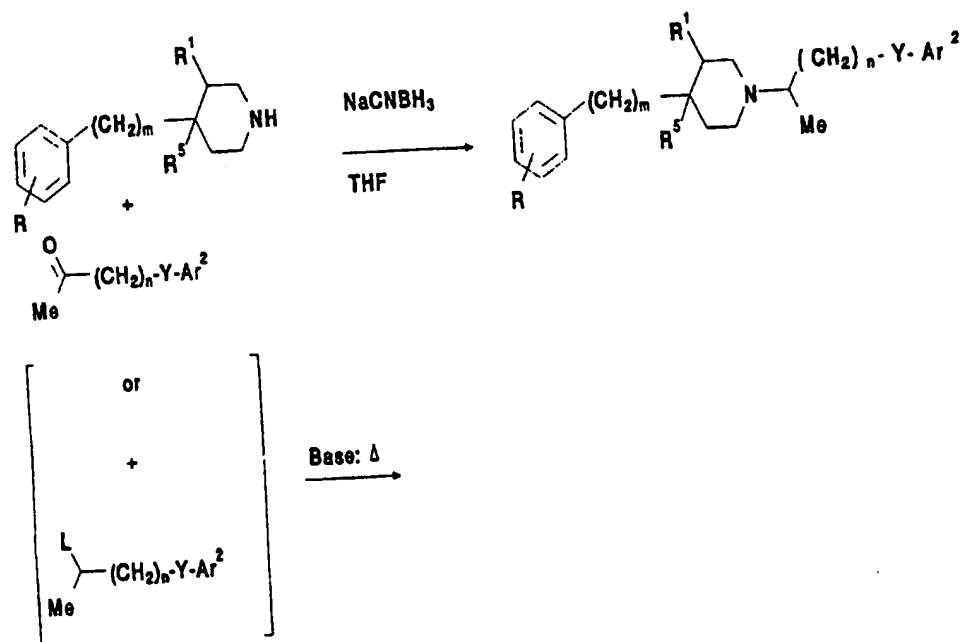
Scheme I.



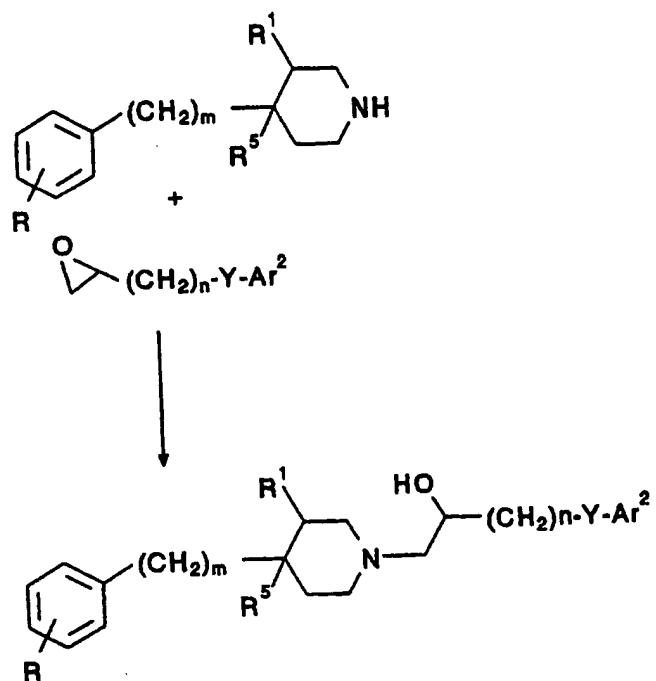
L = leaving group

 $R^2$  and  $R^5 = H$  or  $OH$ , but  $R^1$  and  $R^5$  are not both  $OH$ .

Scheme II.



Scheme III.



The compounds of the present invention are useful in treating or preventing neuronal loss, neurodegenerative diseases and chronic pain. They are also useful as anticonvulsants and for inducing anesthesia, as well as for treating epilepsy and psychosis. The therapeutic and side effect profiles of subtype-selective NMDA receptor subtype antagonists and agonists should be markedly different from the more non-subtype selective NMDA receptor inhibitors. The subtype-selective analogs of the present invention are expected to exhibit little or no untoward side effects caused by non-specific binding with other receptors, particularly, the PCP and glutamate bindings sites associated with the NMDA receptor. In addition, selectivity for different NMDA receptor subtypes will reduce side effects such as sedation that are common to non-subtype-selective NMDA receptor antagonists. The compounds of the present invention are effective in treating or preventing the adverse consequences of the hyperactivity of the excitatory amino acids, e.g. those which are involved in the NMDA receptor system, by preventing the ligand-gated cation channels from opening and allowing excessive influx of  $Ca^{++}$  into neurons, as occurs during ischemia.

Neurodegenerative diseases which may be treated with the compounds of the present invention include those selected from the group consisting of Alzheimer's disease, amyotrophic lateral sclerosis, Huntington's disease, Parkinson's disease and Down's syndrome.

The compounds of the present invention find particular utility in the treatment or prevention of neuronal loss associated with multiple strokes which give rise to dementia. After a patient has been diagnosed as suffering from a stroke, the compounds of the present invention may be administered to ameliorate the

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immediate ischemia and prevent further neuronal damage that may occur from recurrent strokes.

Moreover, the compounds of the present invention are  
5 able to cross the blood/brain barrier which makes them particularly useful for treating or preventing conditions involving the central nervous system.

The compounds of the invention find particular utility  
10 in treating or preventing the adverse neurological consequences of surgery. For example, coronary bypass surgery requires the use of heart-lung machines which tend to introduce air bubbles into the circulatory system which may lodge in the brain. The presence of  
15 such air bubbles robs neuronal tissue of oxygen, resulting in anoxia and ischemia. Pre- or post-surgical administration of the compounds of the present invention will treat or prevent the resulting ischemia. In a preferred embodiment, the compounds of the  
20 invention are administered to patients undergoing cardiopulmonary bypass surgery or carotid endarterectomy surgery.

The compounds of the present invention also find  
25 utility in treating or preventing chronic pain. Such chronic pain may be the result of surgery, trauma, headache, arthritis, pain from terminal cancer or degenerative diseases. The compounds of the present invention also find particular utility in the treatment  
30 of phantom pain that results from amputation of an extremity. In addition to treatment of pain, the compounds of the invention are also expected to be useful in inducing anesthesia, either general or local anesthesia, for example, during surgery.

35

The selective NMDA receptor subtype antagonists, agonists and modulators may be tested for in vivo

- anticonvulsant activity after intraperitoneal or intravenous injection using a number of anticonvulsant tests in mice (audiogenic seizure model in DBA-2 mice, pentylenetetrazol-induced seizures in mice, maximum electroshock seizure test (MES) or NMDA-induced death). The compounds may also be tested in drug discrimination tests in rats trained to discriminate PCP from saline. It is expected that most of the compounds of the present invention will not generalize to PCP at any dose. In addition, it is also expected that none of the compounds will produce a behavioral excitation in locomotor activity tests in the rodent. It is expected that such results will suggest that the selective NMDA receptor subtype antagonists and agonists of the present invention do not show the PCP-like behavioral side effects that are common to NMDA channel blockers such as MK-801 and PCP or to competitive NMDA antagonists such as CGS 19755.
- 20 The selective NMDA receptor subtype antagonists and agonists are also expected to show potent activity in vivo after intraperitoneal or intravenous injection suggesting that these compounds can penetrate the blood/brain barrier.
- 25 Elevated levels of glutamate has been associated with glaucoma. In addition, it has been disclosed that glaucoma management, particularly protection of retinal ganglion cells, can be achieved by administering to a patient a compound capable of reducing glutamate-induced excitotoxicity in a concentration effective to reduce the excitotoxicity. See WO94/13275. Thus, the compounds of the present invention, which are expected to cross the blood-retina barrier, are also expected to be useful in the treatment of glaucoma. Preferably, the invention is directed to the treatment of patients which have primary open-angle glaucoma, chronic closed-

angle glaucoma, pseudo exfoliation, or other types of glaucoma or ocular hypertension. Preferably, the compound is administered over an extended period (e.g. at least six months and preferably at least one year),  
5 regardless of the changes in the patient's intraocular pressure over the period of administration. The compounds of the present invention are also useful in treating CMV retinitis, particularly in combination with antiviral agents. CMV afflicts the ganglion cell  
10 layer which may result in higher levels of glutamate. Thus, NMDA receptor antagonists could block retinitis by blocking the toxicity effect of high levels of glutamate.

15 Aminoglycoside antibiotics have been used successfully in the treatment of serious Gram-negative bacterial infections. However, prolonged treatment with these antibiotics will result in the destruction of sensory hearing cells of the inner ear and consequently, induce  
20 permanent loss of hearing. A recent study of Basile, et al. (Nature Medicine, 2:1338-1344, 1996) indicated that aminoglycosides produce a polyamine-like enhancement of glutamate excitotoxicity through their interaction with the NMDA receptor. Thus, compounds of  
25 the present invention with NMDA receptor antagonist activity will be useful in preventing aminoglycoside antibiotics-induced hearing loss by antagonizing their interaction with the receptor.

30 The compounds of the present invention are useful in treating headaches, in particular, migraine headaches. During migraine attack, a sensory disturbance with unique changes of brain blood flow will result in the development of characteristic migraine auras. Since  
35 this unique phenomena has been replicated in animal experiments with cortical-spreading depression (CSD) of Lea6, A.A.P.J., Neurophysiol. 7:359-390 (1944), CSD is

considered an important phenomena in the pathophysiology of migraine with aura (Tepley et al., In: Biomagnetism, eds. S. Williamson, L. Kaufmann, pp. 327-330, Plenum Press, New York (1990)). The CSD is associated with the propagation (2-6mm/s) of transient changes in electrical activity which relate to the failure of ion homeostasis in the brain, efflux of excitatory amino acids from the neurons and increased energy metabolism (Lauritzen, M., Acta Neurol. Scand. 76 (Suppl. 113):4-40 (1987)). It has been demonstrated that the initiation of CSD in a variety of animals, including humans, involved the release of glutamate and could be triggered by NMDA (Curtis et al., Nature 191:1010-1011 (1961); and Lauritzen et al., Brain Res. 475:317-327 (1988)). Subtype selective NMDA antagonists will be therapeutically useful for migraine headache because of their expected low side effects, their ability to cross the blood brain barrier and their systemic bioavailability.

Bladder activity is controlled by parasympathetic preganglionic neurons in the sacral spinal cord (DeGroat et al., J. Auton. Nerv. Sys. 3:135-160(1981)). In humans, it has been shown that the highest density of NMDA receptors in the spinal cord are located at the sacral level, including those areas that putatively contain bladder parasympathetic preganglionic neurons (Shaw et al., Brain Research 539:164-168 (1991)). Because NMDA receptors are excitatory in nature, pharmacological blockade of these receptors would suppress bladder activity. It has been shown that the noncompetitive NMDA receptor antagonist MK801 increased the frequency of micturition in rat (Vera and Nadelhaft, Neuroscience Letters 134:135-138(1991)). In addition, competitive NMDA receptor antagonists have also been shown to produce a dose-dependent inhibition of bladder and of urethral sphincter activity (US

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Patent 5,192,751). Thus, it is anticipated that subtype-selective NMDA receptor antagonists will be effective in the treatment of urinary incontinence mediated by their modulation on the receptor channel activity.

Non-competitive NMDA receptor antagonist MK801 has been shown to be effective in a variety of animal models of anxiety which are highly predictive of human anxiety (Clineschmidt, B.V. et al., Drug Dev. Res. 2:147-163 (1982)). In addition, NMDA receptor glycine site antagonists are shown to be effective in the rat protentiated startle test (Anthony, E.W., Eur. J. Pharmacol. 250:317-324 (1993)) as well as several other animal anxiolytic models (Winslow, J. et al, Eur. J. Pharmacol. 190:11-22 (1990); Dunn, R. et al., Eur. J. Pharmacol. 214:207-214 (1992); and Kehne, J.H. et al, Eur. J. Pharmacol. 193:283-292 (1981)).

Glycine site antagonists, (+) HA-966 and 5,7-dichlorokynurenic acid were found to selectively antagonize d-amphetamine induced stimulation when injected into rat nucleus accumbens but not in striatum (Hutson, P.H. et al., Br. J. Pharmacol. 103:2037-2044 (1991)). Interestingly, (+) HA-966 was also found to block PCP and MK801-induced behavioral arousal (Bristow, L.J. et al., Br. J. Pharmacol, 108:1156-1163 (1993)). These findings suggest that a potential use of NMDA receptor channel modulators, but not channel blockers, as atypical neuroleptics.

It has been shown that in an animal model of Parkinson's disease - MPP<sup>+</sup> or methamphetamine-induced damage to dopaminergic neurons - can be inhibited by NMDA receptor antagonists (Rojas et al., Drug Dev. Res. 29:222-226 (1993); and Sonsalla et al, Science 243:398-400 (1989)). In addition, NMDA receptor antagonists



have been shown to inhibit haloperidol-induced catalepsy (Schmidt, W.J. et al., Amino Acids 1:225-237 (1991)), increase activity in rodents depleted of monoamines (Carlsson et al., Trends Neurosci. 13:272-276 (1990)) and increase ipsilateral rotation after unilateral substantia nigra lesion in rats (Snell, L.D. et al., J. Pharmacol. Exp. Ther. 235:50-57 (1985)). These are also experimental animal models of Parkinson's disease. In animal studies, the antiparkinsonian agent amantadine and memantine showed antiparkinsonian-like activity in animals at plasma levels leading to NMDA receptor antagonism (Danysz, W. et al., J. Neural Trans. 7:155-166, (1994)). Thus, it is possible that these antiparkinsonian agents act therapeutically through antagonism of an NMDA receptor. Therefore, the balance of NMDA receptor activity maybe important for the regulation of extrapyramidal function relating to the appearance of parkinsonian symptoms.

It is well known to use opiates, e.g., morphine, in the medical field to alleviate pain. (As used herein, the term "opiates" is intended to mean any preparation or derivative of opium, especially the alkaloids naturally contained therein, of which there are about twenty, e.g., morphine, noscapine, codeine, papaverine, and thebaine, and their derivatives.) Unfortunately, with continued use, the body builds up a tolerance for the opiate, and, thus, for continued relief, the patient must be subjected to progressively larger doses. Tolerance develops after both acute and chronic morphine administration (Kornetsky et al., Science 162:1011-1012 (1968); Way et al., J. Pharmacol. Exp Ther. 167:1-8 (1969); Huidobro et al., J. Pharmacol. Exp Ther. 198:318-329 (1976); Lutfy et al., J. Pharmacol. Exp Ther. 256:575-580 (1991)). This, in itself, can be detrimental to the patient's health. Furthermore, a time can come when the tolerance is

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substantially complete and the pain killing properties of the drug are no longer effective. Additionally, administration of higher doses of morphine may lead to respiratory depression, causing the patient to stop  
5 breathing. Seeking alternative drugs to produce analgesia without development of tolerance or as an adjunct therapy to block tolerance without interference with analgesia is an active area of research.

10 Recent studies have suggested a modulatory role for the NMDA receptor in morphine tolerance. (Trujillo et al., Science 251:85-87 (1991); Marek et al., Brain Res. 547:77-81 (1991); Tiseo et al., J. Pharmacol. Exp Ther. 264:1090-1096 (1993); Lutfy et al., Brain Res. 616:83-  
15 88 (1993); Herman et al., Neuropsychopharmacology 12:269-294 (1995).) Further, it has been reported that NMDA receptor antagonists are useful for inhibiting opioid tolerance and some of the symptoms of opioid withdrawal. Thus, the present invention is also  
20 directed to the administration of the compounds described herein to inhibit opiate tolerance and to treat or ameliorate the symptoms of opiate withdrawal by blocking the glycine co-agonist site associated with the NMDA receptor.

25

Thus, the present invention is directed to compounds having high affinity to a particular NMDA receptor subtype and low affinity to other sites such as dopamine and other catecholamine receptors. According  
30 to the present invention, those compounds having high binding to a particular NMDA subunit exhibit an  $IC_{50}$  of about 100  $\mu M$  or less in an NMDA subunit binding assay (see Table 1). Preferably, the compounds of the present invention exhibit a selective subunit  $IC_{50}$  of  
35 10  $\mu M$  or less. Most preferably, the compounds of the present invention exhibit a selective subunit  $IC_{50}$  of about 1.0  $\mu M$  or less.

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Compositions within the scope of this invention include all compositions wherein the compounds of the present invention are contained in an amount which is effective to achieve its intended purpose. While individual  
5 needs vary, determination of optimal ranges of effective amounts of each component is within the skill of the art. Typically, the compounds may be administered to mammals, e.g. humans, orally at a dose of 0.0025 to 50 mg/kg, or an equivalent amount of the  
10 pharmaceutically acceptable salt thereof, per day of the body weight of the mammal being treated for anxiety disorders, e.g., generalized anxiety disorder, phobic disorders, obsessional compulsive disorder, panic disorder and post traumatic stress disorders.  
15 Preferably, about 0.01 to about 10 mg/kg is orally administered to treat or prevent such disorders or for schizophrenia or other psychoses. For intramuscular injection, the dose is generally about one-half of the oral dose. For example, for treatment or prevention of  
20 anxiety, a suitable intramuscular dose would be about 0.0025 to about 15 mg/kg, and most preferably, from about 0.01 to about 10 mg/kg.

In the method of treatment or prevention of neuronal  
25 loss in ischemia, brain and spinal cord trauma, hypoxia, hypoglycemia, and surgery, to treat or prevent glaucoma or urinary incontinence, as well as for the treatment of Alzheimer's disease, amyotrophic lateral sclerosis, Huntington's disease, Parkinson's disease  
30 and Down's Syndrome, or in a method of treating a disease in which the pathophysiology of the disorder involves hyperactivity of the excitatory amino acids or NMDA receptor-ion channel related neurotoxicity, the pharmaceutical compositions of the invention may  
35 comprise the compounds of the present invention at a unit dose level of about 0.01 to about 50 mg/kg of body weight, or an equivalent amount of the pharmaceutically

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acceptable salt thereof, either as an acute intravenous injection, intravenous infusion, or on a regimen of 1-4 times per day. When used to treat chronic pain, migraine headache, to induce anesthesia, to treat or  
5 prevent opiate tolerance or to treat opiate withdrawal, the compounds of the invention may be administered at a unit dosage level of from about 0.01 to about 50 mg/kg of body weight, or an equivalent amount of the pharmaceutically acceptable salt thereof, on a regimen  
10 of 1-4 times per day. Of course, it is understood that the exact treatment level will depend upon the case history of the animal, e.g., human being, that is treated. The precise treatment level can be determined by one of ordinary skill in the art without undue  
15 experimentation.

The unit oral dose may comprise from about 0.01 to about 50 mg, preferably about 0.1 to about 10 mg of the compound. The unit dose may be administered one or  
20 more times daily as one or more tablets each containing from about 0.1 to about 10, conveniently about 0.25 to 50 mg of the compound or its solvates.

In addition to administering the compound as a raw  
25 chemical, the compounds of the invention may be administered as part of a pharmaceutical preparation containing suitable pharmaceutically acceptable carriers comprising excipients and auxiliaries which facilitate processing of the compounds into  
30 preparations which can be used pharmaceutically. Preferably, the preparations, particularly those preparations which can be administered orally and which can be used for the preferred type of administration, such as tablets, dragees, and capsules, and also  
35 preparations which can be administered rectally, such as suppositories, as well as suitable solutions for administration by injection or orally, contain from

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about 0.01 to 99 percent, preferably from about 0.25 to 75 percent of active compound(s), together with the excipient.

5 Also included within the scope of the present invention are the non-toxic pharmaceutically acceptable salts of the compounds of the present invention. Acid addition salts are formed by mixing a solution of the particular selective NMDA receptor subtype antagonist or agonist  
10 of the present invention with a solution of a pharmaceutically acceptable non-toxic acid such as hydrochloric acid, fumaric acid, maleic acid, succinic acid, acetic acid, citric acid, tartaric acid, carbonic acid, phosphoric acid, oxalic acid, and the like.

15

The pharmaceutical compositions of the invention may be administered to any animal which may experience the beneficial effects of the compounds of the invention. Foremost among such animals are mammals, e.g., humans,  
20 although the invention is not intended to be so limited.

The pharmaceutical compositions of the present invention may be administered by any means that achieve  
25 their intended purpose. For example, administration may be by parenteral, subcutaneous, intravenous, intramuscular, intraperitoneal, transdermal, or buccal routes. Alternatively, or concurrently, administration may be by the oral route. The dosage administered will  
30 be dependent upon the age, health, and weight of the recipient, kind of concurrent treatment, if any, frequency of treatment, and the nature of the effect desired.

35 The pharmaceutical preparations of the present invention are manufactured in a manner which is itself known, for example, by means of conventional mixing,

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granulating, dragee-making, dissolving, or lyophilizing processes. Thus, pharmaceutical preparations for oral use can be obtained by combining the active compounds with solid excipients, optionally grinding the  
5 resulting mixture and processing the mixture of granules, after adding suitable auxiliaries, if desired or necessary, to obtain tablets or dragee cores.

Suitable excipients are, in particular, fillers such as  
10 saccharides, for example lactose or sucrose, mannitol or sorbitol, cellulose preparations and/or calcium phosphates, for example tricalcium phosphate or calcium hydrogen phosphate, as well as binders such as starch paste, using, for example, maize starch, wheat starch,  
15 rice starch, potato starch, gelatin, tragacanth, methyl cellulose, hydroxypropylmethylcellulose, sodium carboxymethylcellulose, and/or polyvinyl pyrrolidone. If desired, disintegrating agents may be added such as the above-mentioned starches and also carboxymethyl-  
20 starch, cross-linked polyvinyl pyrrolidone, agar, or alginic acid or a salt thereof, such as sodium alginate. Auxiliaries include, without limitation, flow-regulating agents and lubricants, for example, silica, talc, stearic acid or salts thereof, such as  
25 magnesium stearate or calcium stearate, and/or polyethylene glycol. Dragee cores are provided with suitable coatings which, if desired, are resistant to gastric juices. For this purpose, concentrated saccharide solutions may be used, which may optionally  
30 contain gum arabic, talc, polyvinyl pyrrolidone, polyethylene glycol and/or titanium dioxide, lacquer solutions and suitable organic solvents or solvent mixtures. In order to produce coatings resistant to gastric juices, solutions of suitable cellulose  
35 preparations such as acetyl-cellulose phthalate or hydroxypropylmethyl-cellulose phthalate, are used. Dye stuffs or pigments may be added to the tablets or

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dragee coatings, for example, for identification or in order to characterize combinations of active compound doses.

5 Other pharmaceutical preparations which can be used orally include push-fit capsules made of gelatin, as well as soft, sealed capsules made of gelatin and a plasticizer such as glycerol or sorbitol. The push-fit capsules can contain the active compounds in the form  
10 of granules which may be mixed with fillers such as lactose, binders such as starches, and/or lubricants such as talc or magnesium stearate and, optionally, stabilizers. In soft capsules, the active compounds are preferably dissolved or suspended in suitable  
15 liquids, such as fatty oils, or liquid paraffin. In addition, stabilizers may be added.

Possible pharmaceutical preparations which can be used rectally include, for example, suppositories, which  
20 consist of a combination of one or more of the active compounds with a suppository base. Suitable suppository bases are, for example, natural or synthetic triglycerides, or paraffin hydrocarbons. In addition, it is also possible to use gelatin rectal  
25 capsules which consist of a combination of the active compounds with a base. Possible base materials include, for example, liquid triglycerides, polyethylene glycols, or paraffin hydrocarbons.

30 Suitable formulations for parenteral administration include aqueous solutions of the active compounds in water-soluble form, for example, water-soluble salts and alkaline solutions. In addition, suspensions of the active compounds as appropriate oily injection  
35 suspensions may be administered. Suitable lipophilic solvents or vehicles include fatty oils, for example, sesame oil, or synthetic fatty acid esters, for

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example, ethyl oleate or triglycerides or polyethylene glycol-400 (the compounds are soluble in PEG-400).

Aqueous injection suspensions may contain substances which increase the viscosity of the suspension include, for example, sodium carboxymethyl cellulose, sorbitol, and/or dextran. Optionally, the suspension may also contain stabilizers.

The characterization of NMDA subunit binding sites in vitro has been difficult because of the lack of selective drug ligands. Thus, the compounds of the present invention may be used to characterize the NMDA subunits and their distribution. Particularly preferred subtype-selective NMDA receptor antagonists and agonists of the present invention which may be used for this purpose are isotopically radiolabelled derivatives, e.g., where one or more of the atoms are replaced with  $^3\text{H}$ ,  $^{11}\text{C}$ ,  $^{14}\text{C}$ ,  $^{15}\text{N}$ , or  $^{18}\text{F}$ .

## Electrophysiological Assays at NMDA receptor subunits

Preparation of RNA. cDNA clones encoding the NR1A, NR2A, NR2B, NR2C and NR2D rat NMDA receptor subtypes were provided by Dr. P.H. Seeburg (see, Moriyoshi et al., Nature (Lond.) 354:31-37 (1991); Kutsuwada et al., Nature (Lond.) 358:36-41 (1992) Monyer et al., Science (Washington, D.C.) 256:1217-1221 (1992); Ikeda et al., FEBS Lett. 313:34-38 (1992); Ishii et al., J. Biol. Chem. 268:2836-2843 (1993) for details of these clones or their mouse homologs). The clones were transformed into appropriate host bacteria and plasmid preparations were made with conventional DNA purification techniques. A sample of each clone was linearized by restriction enzyme digestion and cRNA was synthesized with T3 RNA polymerase. The cRNA was diluted to 400 ng/ $\mu\text{l}$  and stored in 1  $\mu\text{l}$  aliquots at  $-80^\circ\text{C}$  until injection.



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The *Xenopus* oocyte expression system. Mature female *Xenopus laevis* were anaesthetized (20-40 min) using 0.15% 3-aminobenzoic acid ethyl ester (MS-222) and 2-4 ovarian lobes were surgically removed. Oocytes at 5 developmental stages IV-VI (Dumont, J.N., J. Morphol. 136:153-180 (1972)), were dissected from the ovary still surrounded by enveloping ovarian tissues. Follicle-enclosed oocytes were micro-injected with 1:1 mixtures of cRNA:NR1A + NR2A, 2B, 2C or 2D; injecting 10 ~2, 5, or 20 ng of RNA encoding each receptor subunit. NR1A encoding cRNA was injected alone at ~20 ng. Oocytes were stored in Barth's medium containing (in mM): NaCl, 88; KCl, 1; CaCl<sub>2</sub>, 0.41; Ca(NO<sub>3</sub>)<sub>2</sub>, 0.33; MgSO<sub>4</sub>, 0.82 NaHCO<sub>3</sub>, 2.4; HEPES 5, pH 7.4, with 0.1 mg/ml 15 gentamicin sulphate. While oocytes were still surrounded by enveloping ovarian tissues the Barth's medium was supplemented with 0.1% bovine serum. Oocytes were defolliculated 1-2 days following injections by treatment with collagenase (0.5 mg/ml 20 Sigma Type I for 0.5-1 hr) (Miledi and Woodward, J. Physiol. (Lond.) 416:601-621 (1989)) and subsequently stored in serum-free medium.

Electrical recordings were made using a conventional 25 two-electrode voltage clamp (Dagan TEV-200) over periods ranging between 3-21 days following injection. (Woodward et al., Mol. Pharmacol. 41: 89-103 (1992)). Oocytes were placed in a 0.1 ml recording chamber continuously perfused (5-15 ml min<sup>-1</sup>) with frog Ringer's 30 solution containing (in mM): NaCl, 115; KCl, 2; CaCl<sub>2</sub>, 1.8; HEPES, 5; pH 7.4. Drugs were applied by bath perfusion. Using oocytes expressing different subunit combinations of NMDA receptor, NMDA currents were activated by co-application of glutamate (100 μM) and 35 glycine (1-100 μM). Inhibitory potency of the novel antagonists was assessed on responses elicited by fixed concentrations of glutamate and glycine, by measuring

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reductions in current induced by progressively increasing concentrations of antagonist.

Concentration-inhibition curves were fit with equation 1.

5

$$I/I_{\text{control}} = 1/(1 + ([\text{antagonist}]/10^{-\text{pIC}_{50}})^n) \quad \text{Eq. 1}$$

in which  $I_{\text{control}}$  is the current evoked by agonists alone,  $\text{pIC}_{50} = -\log \text{IC}_{50}$ ,  $\text{IC}_{50}$  is the concentration of antagonist that produces half maximal inhibition, and  $n$  is the slope factor. (De Lean et al., Am. J. Physiol. 235:E97-102 (1978)). For incomplete curves analysis by fitting was unreliable and  $\text{IC}_{50}$  values were calculated by simple regression over linear portions of the curves (Origin: Microcal Software).

#### Induction of Focal Ischemia

Rats were intubated and maintained under anesthesia with 2% of halothane. Body temperature was maintained at 37.5°C during surgery by means of a warming pad and a rectal probe connected to the control unit. The common carotid arteries (CCA) were isolated, and a loose silk ligature was placed around each CCA. A vertical skin incision was made between the left orbit and the auditory canal. The posterior part of the zygoma was removed and a small opening (2.0-2.5 mm) was drilled dorsorostrally to the foramen ovale under constant saline irrigation. The dura was opened with a microsurgical hook and the brain gently retracted to expose the bifurcation of the internal carotid artery and the middle cerebral artery (MCA). The ipsilateral CCA was ligated and the MCA coagulated from its origin to the olfactory tract. The contralateral CCA was occluded with an arterial clip. All cuts were sutured and an i.v. line was connected to an infusion pump for delivery of the compound of the invention. Two hours

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after MCA occlusion, the clip on the contralateral CCA was removed. Rectal temperature was measured 2 hours after MCA occlusion (MCA-0).

#### 5 Maximal Electroshock-induced Seizures

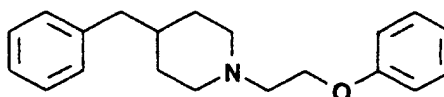
Seizures were induced by application of current (50 mA, 60 pulses/sec, 0.8 sec pulse width, 1 sec duration, d.c.) through saline-coated corneal electrodes using a Ugo Basile ECT device (Model 7801). Mice were restrained by gripping the loose skin on their dorsal surface, electrodes were held lightly against the two cornea, then current was applied and mice were observed for a period of up to 30 sec for the occurrence of a tonic hindlimb extensor response. A tonic seizure was defined as a hindlimb extension in excess of 90 degrees from the plane of the body. Results were treated in a quantal manner.

The examples which follow are intended as an illustration of certain preferred embodiments of the invention, and no limitation of the invention is implied.

25

#### Example 1

#### 4-Benzyl-1-(2-phenoxyethyl)piperidine



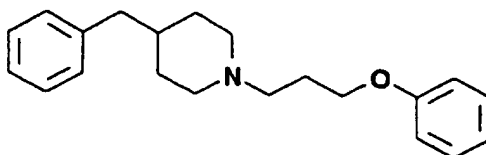
4-Benzylpiperidine was treated with 1-bromo-2-phenoxyethane and excess potassium carbonate as a solution in methylethylketone and heated at reflux for 12 hours. Standard workup and chromatography gave the title compound.

35

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## Example 2

## 4-Benzyl-1-(3-phenoxypropyl)piperidine



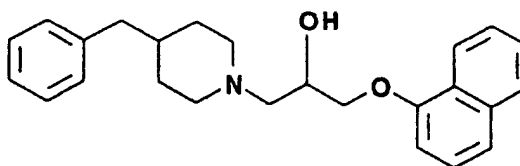
5

A solution of 4-benzylpyridine and 1-bromo-3-phenoxypropane in acetone was stirred at room temperature overnight. After removal of the solvent, the residue was dissolved in ethanol and treated with sodium borohydride to give the tetrahydropyridine adduct. Reduction of the double bond was accomplished in MeOH under a hydrogen atmosphere (50 psi) using 10% Pd-C as a catalyst to give the title compound.

15

## Example 3

## 4-Benzyl-1-[2-hydroxy-3-(1-naphthyloxy)propyl]piperidine



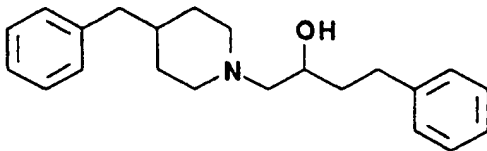
20

A mixture of 1-naphthyl alcohol, chloromethyloxirane, potassium carbonate and methylethylketone was heated at reflux for 5 hours to give 2-(1-naphthyloxy)methyloxirane. This intermediate was treated with 4-benzylpiperidine to give the title compound.

## Example 4

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## 4-Benzyl-1-[(2-hydroxy-4-phenyl)butyl]piperidine

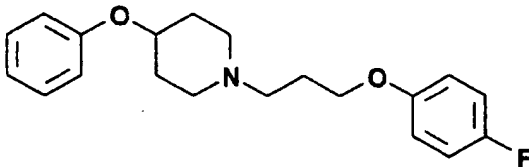


5 A solution of 4-phenyl-1-butene in chloroform was treated with m-chloroperbenzoic acid and stirred for 1.5 hours. Standard workup and chromatography gave the epoxide. Condensation of the epoxide and 4-benzylpiperidine in refluxing toluene gave the title 10 compound.

## Example 5

## 4-Phenoxy-1-[(4-fluorophenoxy)propyl]piperidine

15

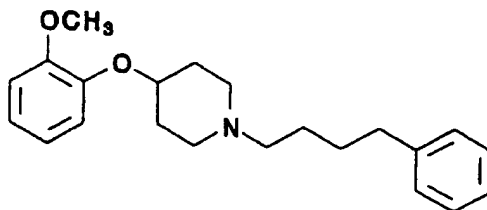


A mixture of 4-phenoxypyridine and benzylbromide in acetone was stirred overnight at room temperature. After removal of the solvent, the residue was dissolved 20 in methanol, cooled to -20°C and treated portionwise with sodium borohydride, and warmed to 0°C. After a standard workup and purification, the resulting tetrahydropyridine adduct was dissolved in methanol and hydrogenated using 20% Pd-C as a catalyst to provide 4-25 phenoxypiperidine. A mixture of 4-phenoxypiperidine and 1-bromo-3-(4-fluorophenoxy)propane in acetone with excess potassium carbonate was heated at reflux for 12 hours to give the title compound.

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## Example 6

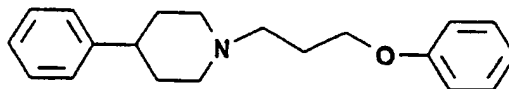
## 4-(2-Methoxyphenoxy)-1-(4-phenylbutyl)piperidine



5 A solution of 4-(2-methoxyphenoxy)pyridine was treated with 1-bromo-4-phenylbutane in acetone to give the pyridinium salt. Sequential reduction with sodium borohydride in ethanol and catalytic hydrogenation using 10% Pd-C as a catalyst in methanol gave the title 10 compound.

## Example 7

## 1-(3-Phenoxypropyl)-4-phenylpiperidine

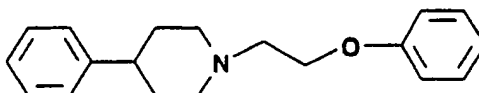


15 A mixture of 3-phenoxypropyl bromide (224 mg, 1.04 mmol), 4-phenylpiperidine (140 mg, 0.870 mmol) and  $K_2CO_3$  (264 mg, 1.91 mmol) in 15 mL of EtOH was refluxed under  $N_2$  for 12 hr. The inorganic salt was removed through a short column of silica gel and washed with EtOAc (3X15 20 mL). The filtrate was evaporated in vacuo to give a residue, which was purified by flash chromatography giving the title as a pale yellow oil (165 mg, 64%):  $^1H$  NMR ( $CDCl_3$ ) 1.90 (m, 4 H), 2.10 (m, 4 H), 2.55 (m, 1H), 2.70 (bs, 2 H), 3.20 (bs, 2 H), 4.05 (m, 2 H), 6.92 (m, 25 4 H), 7.29 (m, 6 H).

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## Example 8

## 1-(2-Phenoxyethyl)-4-phenylpiperidine

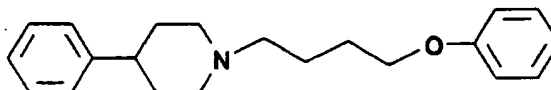


5

The compound was prepared in a manner similar to example 7. From 2-phenoxyethyltosylate (380 mg, 1.30 mmol) and 4-phenylpiperidine (167 mg, 1.04 mmol) there was obtained the amine as a pale yellow oil (224 mg, 77%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.91 (m, 4 H), 2.40 (bs, 2 H), 2.60 (m, 1H), 3.00 (bs, 2 H), 3.25 (bs, 2 H), 4.25 (m, 2 H), 6.94 (m, 4 H), 7.30 (m, 6 H).

## Example 9

## 15 1-(4-Phenoxybutyl)-4-phenylpiperidine



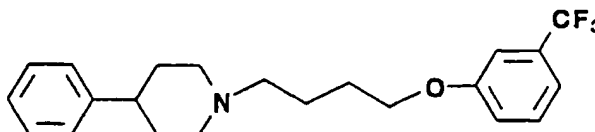
The compound was prepared in a manner similar to example 7. From 4-phenoxybutyl bromide (256 mg, 1.12 mmol) and 4-phenylpiperidine (150 mg, 0.930 mmol) there was obtained the amine as a pale yellow oil (solidified after standing overnight, 196 mg, 68%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.88 (m, 10 H), 2.10 (m, 1 H), 3.00 (bs, 2 H), 3.20 (bs, 2 H), 4.00 (m, 2 H), 6.91 (m, 4 H), 7.26 (m, 6 H).

25

## Example 10

## 1-(4-(3-(Trifluoromethyl)phenoxy)butyl)-4-phenylpiperidine hydrobromide

30



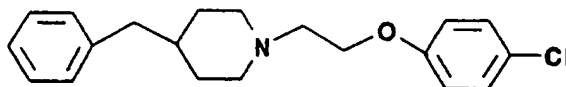
The compound was prepared in a manner similar to example 7. From 1-bromo-4-(3-(trifluoromethyl)phenoxy)butyl bromide

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phenoxy)butane (387 mg, 1.30 mmol) and 4-phenylpiperidine (140 mg, 0.870 mmol) there was obtained the amine as a pale yellow oil (82 mg, 25%). The oil was dissolved in 2 mL of EtOH. To this solution was added 4 mL of 1.2 M HBr in MeOH. The resulting solution was allowed to stir at rt for 2 hr. The MeOH was evaporated *in vacuo* to dryness. Ether (15 mL) was added to the residue and was stirred overnight. The solid was collected by filtration and dried to give the product (110 mg, 100%): mp 134-136°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.94 (m, 2 H), 2.08 (m, 2 H), 2.22 (bs, 2 H), 2.75-2.86 (m, 5 H), 3.10 (m, 2 H), 3.76 (m, 2 H), 4.04 (m, 2 H), 7.10-7.41 (m, 9 H), 11.52 (bs, 1 H). Anal. Calcd for C<sub>22</sub>H<sub>27</sub>NBrF<sub>3</sub>O: C, 57.65; H, 5.94; N, 3.06. Found: C, 57.37; H, 5.65; N, 3.10.

## Example 11

4-Benzyl-1-(2-(4-chlorophenoxy)ethyl)-piperidine hydrochloride



The compound was prepared in a manner similar to example 7. From 4-benzylpiperidine (500 mg, 2.85 mmol, Aldrich) and 2-(4-chlorophenoxy)ethyl bromide (704 mg, 2.99 mmol) there was obtained the amine as a pink oil which solidified upon scratching with a glass rod (835 mg, 89%): mp 72-73°C; The hydrochloride salt was prepared in a manner similar to example 10 as a fluffy, colorless, crystalline solid, mp 177-178°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.55-2.17 (m, 5 H), 2.50-2.82 (m, 4 H), 3.20-3.55 (m, 2 H), 3.65 (d, *J* = 12 Hz, 2 H), 4.53 (t, *J* = 4.2 Hz, 2 H), 6.80 (d, *J* = 8.7 Hz, 2 H), 7.00-7.18 (m, 7 H), 12.68 (bs, 1 H). Anal. Calcd for C<sub>20</sub>H<sub>25</sub>Cl<sub>2</sub>NO: C, 65.57; H, 6.88; N, 3.82. Found: C, 65.45, H, 7.08, N, 3.80

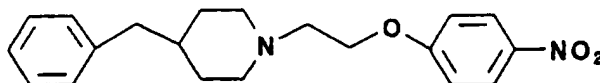


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## Example 12

4-Benzyl-1-(2-(4-nitrophenoxy)ethyl)-  
piperidine hydrobromide

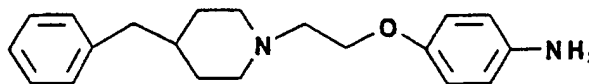
5



The compound was prepared in a manner similar to example 10. From 4-benzylpiperidine (1.00 g, 5.70 mmol) and 1-bromo-2-(4-nitrophenoxy)ethane (1.47 g, 5.98 mmol) there was obtained the title compound as a colorless solid (1.82 g, 76%): mp 155-157°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.16-2.21 (m, 5 H), 2.58-2.89 (m, 4 H), 3.25-3.78 (m, 4 H), 4.74 (t, J = 4.2 Hz, 2 H), 6.90-7.35 (m, 7 H), 8.20 (d, J = 9.0 Hz, 2 H). Anal. Calcd for C<sub>20</sub>H<sub>23</sub>BrN<sub>2</sub>O<sub>3</sub>: C, 57.01; H, 5.98; N, 6.65. Found: C, 57.15; H, 6.03; N, 6.61.

## Example 13

20

1-(2-(4-Aminophenoxy)ethyl)-4-benzylpiperidine  
dihydrobromide

25

A mixture of 4-benzyl-1-(2-(4-nitrophenoxy)ethyl)piperidine hydrobromide (900 mg, 2.14 mmol) and Pd/C (10%; 100 mg) in MeOH (50 mL) was shaken under H<sub>2</sub> (20-30 psi, Parr) for 2.25 h at 25°C. The catalyst was removed by filtration (Celite). The resulting solution was acidified with a dilute solution of HBr in MeOH. The MeOH was removed in vacuo (rotoevap) to give a syrup. Ether (45 mL) was added and the resulting mixture was vigorously stirred at 25°C for 48 h. A gray suspension was obtained. The solid was collected, washed with ether (3 x 3 mL) and dried in vacuo (0.005 Torr, 56°C) to give a beige powder (606 mg, 60%): mp > 130°C; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)

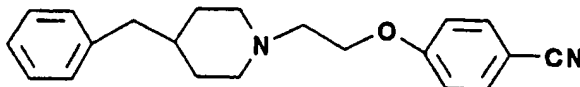
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1.33-1.88 (m, 5 H), 2.38-3.75 (m, 8 H), 4.25-4.45 (m, 2 H), 7.04-7.38 (m, 9 H), 9.49-10.30 (m, 4 H).

## Example 14

5

4-Benzyl-1-(2-(4-cyanophenoxy)ethyl)piperidine



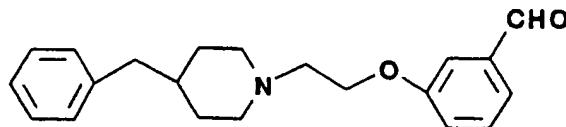
10 The compound was prepared in a manner similar to example 7. From 2-(4-cyano-phenoxy)ethyl bromide (2.26 g, 10.0 mmol) and 4-benzylpiperidine (1.75 g, 10.0 mmol) there was obtained the amine as a solid (2.2 g, 69%): mp 83-85°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.37 (m, 2 H), 1.60 (m, 1 H), 1.63 (m, 2 H), 2.08 (m, 2 H), 2.53 (d, J = 6.6 Hz, 2 H), 2.81 (m, 2 H), 3.00 (d, J = 10.8 Hz, 2 H), 4.15 (t, J = 4.8 Hz, 2 H), 6.92 (d, J = 8.4 Hz, 2 H), 7.15 (m, 5 H), 7.55 (d, J = 8.7 Hz, 2 H).

20

## Example 15

3-((2-(4-Benzylpiperidin-1-yl)ethyl)oxy)-benzaldehyde hydrochloride

25



A) 3-((2-Bromoethyl)oxy)benzaldehyde. A mixture of 3-hydroxybenzaldehyde (4.88 g, 40.0 mmol), 1,2-dibromoethane (75.2 g, 400 mmol) and K<sub>2</sub>CO<sub>3</sub> (13.8 g, 100 mmol) in 50 mL of acetonitrile was allowed to reflux under N<sub>2</sub> for 2 days. The inorganic salt was removed through a short column of silica gel and washed with EtOAc (3 X 50 mL). Evaporation of solvent gave a residue, which was purified by flash chromatography giving the product as a pale yellow oil (7.65 g, 84%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.67 (t, J = 6.3 Hz, 2 H), 4.36 (t, J = 6.3 Hz, 2 H), 7.20-7.49 (m, 4 H), 9.98 (s, 1 H).

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B) 3-((2-Bromoethyl)oxy)benzaldehyde ethylene acetal.  
To a solution of 3-((2-bromoethyl)oxy)benzaldehyde  
(2.29 g, 10.0 mmol) in 50 mL of dry benzene were added  
ethylene glycol (1.22 mL, 22.0 mmol) and of p-  
5 toluenesulfonic acid (50 mg). The resulting solution  
was allowed to reflux for 2 days. The solution was  
washed with saturated NaHCO<sub>3</sub> solution (2 X 20 mL) and  
dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation of solvent gave the  
product as pale yellow oil (2.24 g, 82%): <sup>1</sup>H NMR  
10 (CDCl<sub>3</sub>) 3.64 (t, J = 6.3 Hz, 2 H), 4.03 (m, 2 H), 4.13  
(m, 2 H), 4.31 (t, J = 6.3 Hz, 2 H), 5.98 (s, 1 H),  
6.91-7.31 (m, 4 H).

C) 3-((2-(4-Benzylpiperidin-1-  
15 yl)ethyl)oxy)benzaldehyde ethylene acetal. The  
compound was prepared in a manner similar to example 7.  
From 3-((2-bromoethyl)oxy)benzaldehyde ethylene acetal  
(2.24 g, 8.20 mmol) and 4-benzylpiperidine (1.75 g,  
10.0 mmol) there was obtained the amine as a colorless  
20 oil (2.9 g, 94%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.32 (m, 2 H), 1.60  
(m, 1 H), 1.62 (d, J = 12.9 Hz, 2 H), 2.05 (m, 2 H),  
2.53 (d, J = 6.6 Hz, 2 H), 2.78 (m, 2 H), 2.96 (d, J =  
12 Hz, 2 H), 4.02 (m, 2 H), 4.11 (s, 4 H), 5.79 (s, 1  
H), 6.88-7.25 (m, 9H).

25

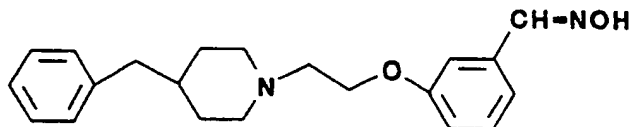
D) 3-((2-(4-Benzylpiperidin-1-  
yl)ethyl)oxy)benzaldehyde hydrochloride. To a solution  
of 3-((2-(4-benzylpiperidin-1-yl)ethyl)oxy)benzaldehyde  
ethylene acetal (1.1 g, 3.0 mmol) in 10 mL of EtOH was  
30 added 9 mL of 2 N HCl solution. The resulting solution  
was allowed to stir at 70°C for 3 hr. The solution was  
neutralized with saturated NaHCO<sub>3</sub> solution to pH 7 and  
extracted with EtOAc (3 X 30 mL). The combined  
extracts were dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation of  
35 solvents gave the product as a pale yellow oil (0.87 g,  
90%). To a solution of this oil (200 mg, 0.62 mmol) in  
5 mL of MeOH was added dropwise 3 mL of 1 M HCl in

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MeOH. The resulting solution was allowed to stir at rt for 10 min. Evaporation of solvent gave an oil, to which was added 45 mL of ether. The mixture was allowed to stir at rt for 2 days. The solid was  
5 collected by filtration and dried in vacuo giving the product as a solid (110 mg, 50%): mp 145-147°C (dec.); <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.72 (m, 2 H), 1.88 (m, 2 H), 2.06 (m, 2 H), 2.62 (d, *J* = 6.30 Hz, 2 H), 2.75 (m, 2 H), 3.41 (s, 2 H), 3.67 (m, 2 H), 4.64 (s, 2 H), 7.11-7.51 (m, 9 H),  
10 9.97 (s, 1 H), 12.71 (s, 1 H).

## Example 16

15 3-((2-(4-Benzylpiperidin-1-yl)ethyl)oxy)-benzaldehyde oxime  
benzaldehyde oxime

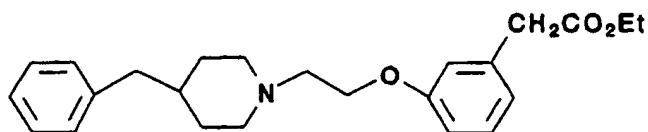


To a solution of 3-((2-(4-benzylpiperidin-1-yl)ethyl)oxy)benzaldehyde (200 mg, 0.620 mmol) in 6 mL  
20 of 50% aqueous EtOH was added a solution of hydroxylamine hydrochloride (110 mg, 1.55 mmol) and sodium acetate (246 mg, 2.77 mmol) in 50% aqueous EtOH (10 mL). The resulting solution was allowed to stir at  
25 room temperature for 3 days. The EtOH was evaporated and a colorless solid was collected by filtration and dried to give the product (160 mg, 70%): mp 141-143°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.40 (m, 2 H), 1.50 (m, 1 H), 1.64 (m, 2 H), 2.12 (m, 2 H), 2.54 (m, 2 H), 2.85 (s, 2 H), 3.08  
30 (m, 2 H), 4.21 (m, 2 H), 6.88-7.28 (m, 9 H), 8.04 (s, 1 H), 10.00 (bs, 1 H).

## Example 17

4-Benzyl-1-(2-(3-(ethoxycarbonylmethyl)-  
phenoxy)ethyl)piperidine

5



A) Ethyl 3-hydroxyphenylacetate. To a solution of 3-hydroxyphenylacetic acid (10 g, 66 mmol) in 200 mL of  
 10 EtOH was added 4 mL of  $H_2SO_4$ . The resulting solution was allowed to reflux for 3 days. The solvent was evaporated in vacuo, water (50 mL) added to the residue, and the resulting mixture was extracted with EtOAc (3 X 30 mL). The combined organic extract was  
 15 dried over  $Na_2SO_4$ . The solvent was evaporated in vacuo to give the product as a colorless oil (11.5 g, 97%):  $^1H$  NMR ( $CDCl_3$ ) 1.26 (t,  $J = 7.2$  Hz, 3 H), 3.57 (s, 3 H), 4.15 (q,  $J = 7.2$  Hz, 2 H), 6.75 (m, 3 H), 7.16 (m, 1 H).

20

B) Ethyl 3-((2-bromoethyl)oxy)phenylacetate. From ethyl 3-hydroxyphenylacetate (3.6 g, 20 mmol), 1,2-dibromoethane (37.6 g, 200 mmol) was obtained the title compound as a pale yellow oil (4.68 g, 82%):  $^1H$  NMR  
 25 ( $CDCl_3$ ) 1.26 (t,  $J = 7.2$  Hz, 3 H), 3.59 (s, 3 H), 3.63 (t,  $J = 6.3$  Hz, 2 H), 4.14 (q,  $J = 7.2$  Hz, 2 H), 4.29 (t,  $J = 6.3$  Hz, 2 H), 6.84 (m, 3 H), 7.24 (m, 1 H).

C) 4-Benzyl-1-(2-(3-(ethoxycarbonylmethyl)phenoxy)ethyl)piperidine. The  
 30 compound was prepared in a manner similar to example 7. From ethyl 3-((2-bromoethyl)oxy)phenylacetate (2.18 g, 7.60 mmol) and 4-benzylpiperidine (1.58 g, 9.00 mmol) there was obtained the amine as a pale yellow oil (2.32  
 35 g, 80%):  $^1H$  NMR ( $CDCl_3$ ) 1.26 (t,  $J = 7.2$  Hz), 1.45 (m, 2 H), 1.61 (m, 1 H), 1.64 (m, 2 H), 2.06 (m, 2 H), 2.54

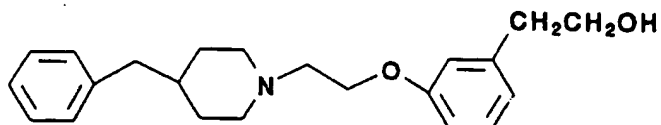
- 80 -

(d,  $J = 6.9$  Hz, 2 H), 2.78 (m, 2 H), 3.00 (d,  $J = 11.4$  Hz, 2 H), 3.64 (s, 3 H), 6.86 (m, 3 H), 7.29 (m, 6 H).

## Example 18

5

4-Benzyl-1-(2-(3-(2-hydroxyethyl)phenoxy)  
ethyl)piperidine



10

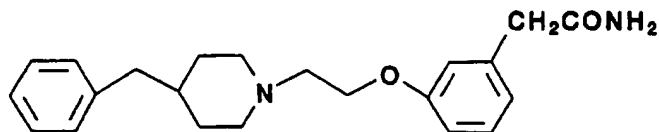
To a suspension of lithium aluminum hydride (150 mg, 4.0 mmol) in 10 mL of anhydrous THF was added dropwise a solution of 4-benzyl-1-(2-(3-(ethoxycarbonylmethyl)phenoxy)ethyl)piperidine (0.382 g, 1.00 mmol) in 2 mL of THF at -78°C. The resulting mixture was allowed to warm to room temperature and was stirred for 12 hr. Water (0.2 mL), 15% NaOH aqueous solution (0.2 mL) and water (1 mL) were added successively. The colorless solid was removed by filtration and washed with EtOAc (3 X 20 mL). The filtrate was dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation of solvents gave a residue, which was purified by flash chromatography giving the title product as colorless oil (223 mg, 66%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.37 (m, 2 H), 1.60 (m, 1 H), 1.63 (m, 2 H), 2.05 (m, 2 H), 2.36 (d,  $J = 6.6$  Hz, 2 H), 2.76 (m, 2 H), 2.82 (m, 2 H), 2.95 (m, 3 H), 3.81 (t,  $J = 6.9$  Hz, 2 H), 4.08 (t,  $J = 6.9$  Hz, 2 H), 6.80 (m, 3 H), 7.17-7.29 (m, 6 H).

25

## Example 19

1-(2-(3-(Aminocarbonylmethyl)phenoxy)ethyl)-  
4-benzylpiperidine

5

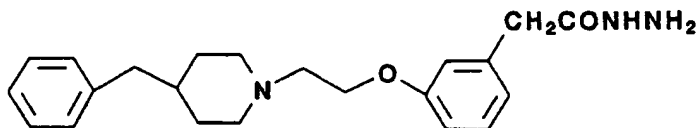


To a solution of 4-benzyl-1-(2-(3-(ethoxycarbonylmethyl)phenoxy)ethyl)piperidine (0.382 g, 1.00 mmol) in 5 mL of MeOH was added 5 mL of 30%  $\text{NH}_4\text{OH}$  solution. The resulting solution was allowed to stir at rt for 12 hr. The MeOH was evaporated in vacuo and water (10 mL) was added. A colorless solid precipitated. The solid was collected by filtration and dried in vacuo giving the title product (218 mg, 62%): mp 100-101°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.31 (m, 2 H), 1.60 (m, 1 H), 1.609 (m, 2 H), 2.04 (m, 2 H), 2.53 (d,  $J$  = 6.6 Hz, 2 H), 2.80 (t,  $J$  = 4.8 Hz, 2 H), 2.95 (d,  $J$  = 11.4 Hz, 2 H), 3.55 (s, 2 H), 4.08 (t,  $J$  = 6 Hz, 2 H), 5.35 (s, 2 H), 6.82 (m, 2 H), 7.13-7.27 (m, 6 H).

## Example 20

4-Benzyl-1-(2-(3-(hydrazinocarbonylmethyl)-  
phenoxy)ethyl)piperidine

25



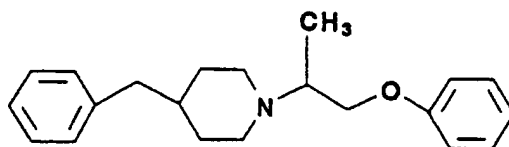
To a solution of 4-benzyl-1-(2-(3-(ethoxycarbonylmethyl)phenoxy)ethyl)piperidine (0.382 g, 1.00 mmol) in 5 mL of MeOH was added 5 mL of hydrazine hydrate. The resulting solution was allowed to stir at rt for 12 hr. The MeOH was evaporated in vacuo and water (10 mL) was added. A colorless solid precipitated. The solid was collected by filtration and dried in vacuo giving the title product (240 mg, 65%): mp 89-91°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.31 (m, 2 H), 1.60

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(m, 1 H), 1.62 (m, 2 H), 2.04 (t,  $J = 11.7$  Hz, 2 H), 2.52 (d,  $J = 6.9$  Hz, 2 H), 2.76 (t,  $J = 6.0$  Hz, 2 H), 2.95 (d,  $J = 11.4$  Hz, 2 H), 3.53 (s, 2 H), 3.83 (bs, 2 H), 4.08 (t,  $J = 6.3$  Hz, 2 H), 6.66 (s, 1 H), 6.79 (m, 5 H), 7.12-7.27 (m, 6 H).

## Example 21

10 4-Benzyl-1-(1-methyl-2-phenoxyethyl)-  
piperidine hydrobromide



A) 1-Phenoxypropan-2-ol. To a suspension of lithium  
15 aluminum hydride (6.0 g, 0.15 mol) in 50 mL of THF was  
added dropwise a solution of phenoxyacetone (15 g, 0.10  
mol) in 5 mL of THF at  $-78^{\circ}\text{C}$ . The mixture was allowed  
to warm to room temperature and was stirred for an  
additional 2 h. Water (6.0 mL), 15% NaOH solution (6.0  
20 mL) and water (18 mL) were added to the reaction  
mixture successively. The resulting mixture was  
extracted with EtOAc (15 mL) and ether (2X50 mL). The  
combined organic extract was dried over  $\text{Na}_2\text{SO}_4$ . The  
solvent was evaporated in vacuo to give a residue,  
25 which was purified by distillation giving the product  
as a colorless oil (12.5 g, 82%): bp  $65-67^{\circ}\text{C}$ , 0.06  
Torr;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.28 (d,  $J = 7.0$  Hz, 3 H), 2.35  
(bs, 1 H), 3.80 (m, 1 H), 3.97 (m, 1H), 4.20 (m, 1 H),  
6.93 (m, 3 H), 7.32 (m, 2 H).

30

B) 1-Phenoxy-2-tosylpropane. To a solution of 1-  
phenoxypropan-2-ol (5.0 g, 33 mmol) in 20 mL of  $\text{CH}_2\text{Cl}_2$ ,  
and 25 mL of pyridine was added tosyl chloride (12.6 g,  
66.0 mmol) in one portion at  $0^{\circ}\text{C}$ . The resulting  
35 solution was allowed to stir overnight at rt. The  
solution was poured into ice water (100 g) and the  
organic layer was separated. The aqueous layer was



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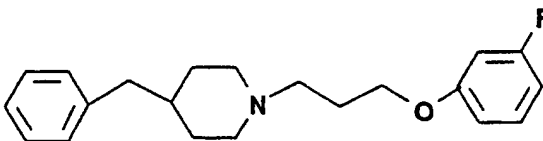
extracted with  $\text{CH}_2\text{Cl}_2$  (2X50 mL). The combined organic layer was washed with 1.0 N HCl (2 X 50 mL) and 0.1 M  $\text{NaHCO}_3$  solution (30 mL) and dried. Evaporation of solvent gave a residue, which was recrystallized from 5  $\text{CH}_2\text{Cl}_2$ /hexanes to give the product as a colorless solid (7.5 g, 74%): mp 92-94°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.42 (d,  $J$  = 9.6 Hz, 3 H), 2.44 (s, 3 H), 3.90 (m, 1 H), 4.04 (m, 1 H), 4.83 (m, 1 H), 6.68 (d,  $J$  = 8.1 Hz, 2 H), 6.94 (m, 1 H), 7.33 (m, 4 H), 7.79 (d,  $J$  = 8.1 Hz, 2 H).

10

C) 4-Benzyl-1-(1-methyl-2-phenoxyethyl)piperidine hydrobromide. The compound was prepared in a manner similar to example 10. From 1-phenoxy-2-tosylpropane (550 mg, 1.80 mmol) and 4-benzylpiperidine (263 mg, 1.50 mmol) there was obtained the hydrobromide salt as a solid (290 mg, 50%): mp 151-153°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.60 (m, 3 H), 1.83 (m, 2 H), 2.23 (m, 2 H), 2.65 (m, 2 H), 2.93 (m, 2 H), 3.57 (m, 4 H), 4.24 (m, 1 H), 4.56 (m, 1 H), 6.87-7.27 (m, 10 H), 11.20 (bs, 1 H); Anal. 20 Calcd for  $\text{C}_{21}\text{H}_{28}\text{NBrO}$ : C, 64.60; H, 7.23; N, 3.59. Found: C, 64.27; H, 7.37; N, 3.58.

## Example 22

25 4-Benzyl-1-(3-(3-fluorophenoxy)propyl)-piperidine hydrobromide



30 The compound was prepared in a manner similar to example 10. From 4-benzylpiperidine (500 mg, 2.85 mmol) and 1-bromo-3-(3-fluorophenoxy)propane (697 mg, 2.99 mmol) there was obtained the hydrobromide salt as a colorless powder (838 mg, 72%): mp 155.5-157.5°C; 35  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.60-1.94 (m, 3 H), 2.05-2.25 (m, 2 H), 2.41-2.72 (m, 6 H), 3.11-3.21 (m, 2 H), 3.63 (d,  $J$  = 11 Hz, 2 H), 4.05 (t,  $J$  = 5.4 Hz, 2 H), 6.52-6.71 (m, 3

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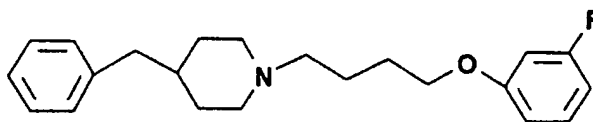
H), 7.09-7.34 (m, 6 H), 11.40 (bs, 1 H). Anal. Calcd for  $C_{21}H_{27}BrFNO$ : C, 61.77; H, 6.66; N, 3.43. Found: C, 61.86; H, 6.80; N, 3.40.

5

## Example 23

4-Benzyl-1-(4-(3-fluorophenoxy)butyl)-  
piperidine hydrobromide

10

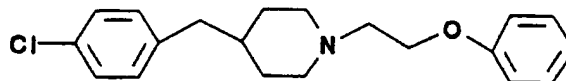


The compound was prepared in a manner similar to example 10. From 4-benzylpiperidine (500 mg, 2.85 mmol) and 1-bromo-4-(3-fluorophenoxy)butane (1.06 g, 4.28 mmol) there was obtained the hydrobromide salt as a colorless powder (240 mg, 88%): mp 124.5-127.5°C;  $^1H$  NMR ( $CDCl_3$ ) 1.70-1.94 (m, 5 H), 2.05-2.23 (m, 4 H), 2.51-2.60 (m, 4 H), 2.93-3.08 (m, 2 H), 3.60 (d,  $J$  = 11 Hz, 2 H), 3.97 (t,  $J$  = 5.7 Hz, 2 H), 6.52-6.70 (m, 3 H), 7.12-7.30 (m, 6 H), 11.35 (bs, 1 H). Anal. Calcd for  $C_{22}H_{29}BrFNO$ : C, 62.56; H, 6.92; N, 3.32. Found: C, 62.54; H, 7.15; N, 3.42.

25

## Example 24

4-(4-Chlorobenzyl)-1-(2-phenoxyethyl)-  
piperidine hydrochloride



30

The compound was prepared in a manner similar to example 10. From 4-(4-chlorobenzyl)piperidine hydrochloride (500 mg, 2.03 mmol) and 2-phenoxyethyl tosylate (623 mg, 2.13 mmol) there was obtained the hydrochloride salt as a colorless powder (455 g, 62%), mp 200-202°C;  $^1H$  NMR ( $CDCl_3$ ) 1.55-1.89 (m, 3 H), 2.06 (q,  $J$  = 12 Hz, 2 H), 2.50-2.89 (m, 4 H), 3.20-3.55 (m, 2 H), 3.66 (d,  $J$  = 12 Hz, 2 H), 4.54 (bs, 2 H), 6.86

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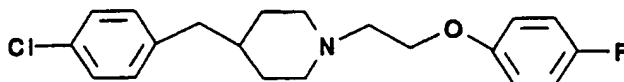
(d,  $J = 7.8$  Hz, 2 H), 6.95-7.09 (m, 3 H), 7.22-7.34 (m, 4 H), 12.64 (bs, 1 H). Anal. Calcd for  $C_{20}H_{23}Cl_2NO$ : C, 65.57; H, 6.88; N, 3.82. Found: C, 65.42; H, 6.65; N, 3.57.

5

## Example 25

4-(4-Chlorobenzyl)-1-(2-(4-fluorophenoxy)-ethyl)piperidine hydrobromide

10



- A) 2-(4-Fluorophenoxy)ethyl bromide. From 4-fluorophenol (10.0 g, 89.2 mmol) and 1,2-dibromoethane (38.4 mL, 83.8 g, 446 mmol) was obtained a colorless liquid (8.90 g, 46%):  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 3.62 (t,  $J = 6.3$  Hz, 2 H), 4.25 (t,  $J = 6.3$  Hz, 2 H), 6.82-6.91 (m, 2 H), 6.92-7.03 (m, 2 H).
- 20 B) 4-(4-Chlorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrobromide. A mixture of 4-(4-chlorobenzyl)piperidine hydrochloride (1.00 g, 4.06 mmol), 2-(4-fluorophenoxy)ethyl bromide (933 mg, 4.26 mmol) and  $\text{K}_2\text{CO}_3$  (1.15 g, 8.32 mmol) in  $\text{CH}_3\text{CN}$  (30 mL) was stirred at reflux under  $\text{N}_2$  for 3 d. The reaction was allowed to cool to  $25^\circ\text{C}$ . The reaction was then added to 10% HCl (100 mL) and extracted with  $\text{CHCl}_3$  (3 x 50 mL). The extract was washed with 5%  $\text{NH}_4\text{OH}$  (2 x 50 mL), filtered through cotton and the solvent removed on a rotoevap to give a colorless oil. The product was purified chromatographically on silica gel (2.5 x 30 cm). Elution with  $\text{CHCl}_3$  removed the more mobile impurities. Elution with 2% EtOH/99%  $\text{CHCl}_3$  removed the product. The solvent was removed from the product fractions on a rotoevap to give a colorless solid. The solid was dissolved in warm MeOH (10 mL), filtered through Celite and the MeOH removed on a rotoevap to give an colorless solid. The solid was dried in vacuo

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(0.005 Torr, 25°C) to give an colorless solid (1.23 g, 87%): mp 85-87.5°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.25-1.68 (m, 5 H), 2.04 (t, J = 12 Hz, 2 H), 2.50 (d, J = 6.9 Hz, 2 H), 2.76 (t, J = 6.0 Hz, 2 H), 2.97 (d, J = 11 Hz, 2 H), 4.05 (t, J = 6.0 Hz, 2 H), 6.77-7.00 (m, 4 H), 7.06 (d, J = 8.1 Hz, 2 H), 7.24 (d, J = 8.1 Hz, 2 H);

The hydrobromide salt was prepared according to the following procedure. A solution of the free base (1.00 g, 2.87 mmol) in MeOH (15 mL, prepared with warming) was treated with a dilute solution of HBr in MeOH until the amine solution became permanently acidic (pH paper). The solvent was removed *in vacuo* to give a syrup. The syrup was stirred vigorously in ether (95 mL) for 18 h to give a yellow suspension. The solid was collected, washed with ether (3 x 3 mL) and dried *in vacuo* (0.005 Torr, 79°C) to yield a pale yellow powder (1.14 g, 93%): mp 117.5-119.5°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.60-1.89 (m, 3 H), 2.08 (q, J = 12 Hz, 2 H), 2.58 (d, J = 6.9 Hz, 2 H), 2.82 (q, J = 11 Hz, 2 H), 3.27-3.48 (m, 2 H), 3.70 (d, J = 12 Hz, 2 H), 4.53 (t, J = 3.6 Hz, 2 H), 6.77-7.10 (m, 6 H), 7.23 (d, J = 8.4 Hz, 2 H), 11.48 (bs, 1 H).

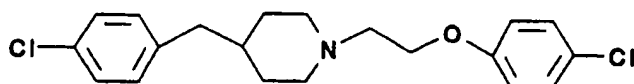
25 An analytical sample was prepared by crystallization of the above powder from 2-butanone/ether as a fluffy crystalline solid, mp 117-118°C. Anal. Calcd for C<sub>20</sub>H<sub>24</sub>BrClFNO: C, 56.03; H, 5.64; N, 3.27. Found: C, 56.14; H, 5.46; N, 3.28.

30

## Example 26

4-(4-Chlorobenzyl)-1-(2-(4-chlorophenoxyethyl)-piperidine hydrochloride

35



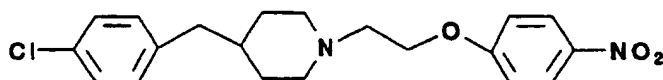
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The compound was prepared in a manner similar to example 25. From 4-(4-chlorobenzyl)piperidine hydrochloride (500 mg, 2.03 mmol) and 2-(4-chlorophenoxy)ethyl bromide (502 mg, 2.13 mmol) there was obtained the hydrochloride salt as a colorless powder (641 g, 81%): mp 167-169°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.55-1.89 (m, 3 H), 2.06 (q, *J* = 13 Hz, 2 H), 2.50-2.82 (m, 4 H), 3.20-3.55 (m, 2 H), 3.65 (d, *J* = 12 Hz, 2 H), 4.53 (t, *J* = 4.2 Hz, 2 H), 6.81 (d, *J* = 8.7 Hz, 2 H), 7.04 (d, *J* = 8.7 Hz, 2 H), 7.20-7.28 (m, 4 H), 12.75 (bs, 1 H); Anal. Calcd for C<sub>20</sub>H<sub>24</sub>Cl<sub>2</sub>NO: C, 59.94; H, 6.04; N, 3.49. Found: C, 60.05; H, 5.85; N, 3.18.

## Example 27

15

4-(4-Chlorobenzyl)-1-(2-(4-nitrophenoxy)ethyl)piperidine hydrobromide



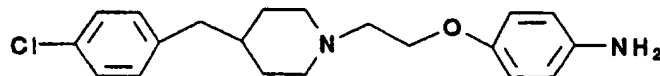
20

The compound was prepared in a manner similar to example 25. From 4-(4-chlorobenzyl)piperidine hydrochloride (1.00 g, 4.06 mmol) and 1-bromo-2-(4-nitrophenoxy)ethane (1.05 g, 4.26 mmol) there was obtained the hydrobromide salt as a colorless solid (1.27 g, 69%): mp 155-158°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.55-2.20 (m, 5 H), 2.52-2.89 (m, 4 H), 3.25-3.78 (m, 4 H), 4.74 (t, *J* = 4.5 Hz, 2 H), 6.98 (d, *J* = 9.3 Hz, 2 H), 7.05 (d, *J* = 8.1 Hz, 2H), 7.25 (d, *J* = 7.5 Hz, 2 H), 8.21 (d, *J* = 8.7 Hz, 2 H), 11.77 (bs, 1H). Anal. Calcd for C<sub>20</sub>H<sub>24</sub>BrClN<sub>2</sub>O<sub>3</sub>: C, 52.70; H, 5.31; N, 6.15. Found: C, 52.82; H, 5.42; N, 6.09.

35

## Example 28

1-(2-(4-Aminophenoxy)ethyl)-4-(4-chlorobenzyl)-piperidine dihydrobromide



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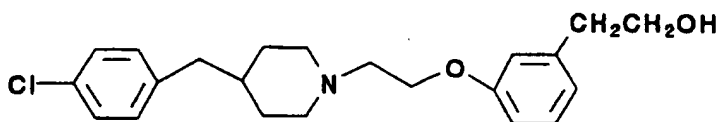
A mixture of 4-(4-chlorobenzyl)-1-(2-(4-nitrophenoxy)ethyl)piperidine hydrobromide (500 mg, 1.10 mmol) and Pd/C (10%, 50 mg) in MeOH (25 mL) was shaken under H<sub>2</sub> (20-30 psi, Parr) for 2.25 h and worked up to give a beige powder (350 mg, 63%): mp > 130°C; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) 1.37-1.88 (m, 5 H), 2.45-3.75 (m, 8 H), 4.30-4.42 (m, 2 H), 7.04-7.38 (m, 8 H), 9.35-10.20 (m, 4 H); HRMS Calcd for C<sub>20</sub>H<sub>23</sub>ClN<sub>2</sub>O: 344.1655. Found: 344.1656.

10

## Example 29

4-(4-Chlorobenzyl)-1-(2-(3-(2-hydroxyethyl)phenoxy)-ethyl)piperidine

15



A) 4-(4-Chlorobenzyl)-1-(2-(3-(ethoxycarbonylmethyl)phenoxy)ethyl) piperidine. The

compound was prepared in a manner similar to example 7. From ethyl 3-((2-bromoethyl)oxy)phenylacetate (2.26 g, 7.80 mmol) and 4-(4-chlorobenzyl)piperidine hydrochloride (2.2 g, 9.0 mmol) there was obtained the amine as a pale yellow oil (1.74 g, 55%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.25 (t, J = 7.2 Hz, 3 H), 1.50 (m, 3 H), 1.61 (m, 2 H), 2.09 (m, 2 H), 2.50 (d, J = 6.3 Hz, 2 H), 2.80 (bs, 2 H), 2.99 (m, 2 H), 3.56 (s, 2 H), 4.13 (m, 4 H), 6.83 (m, 3 H), 7.08 (d, J = 8.1 Hz, 2 H), 7.22 (m, 3 H).

30

B) 4-(4-Chlorobenzyl)-1-(2-(3-(2-hydroxyethyl)phenoxy)ethyl)piperidine. To a suspension

of lithium aluminum hydride (76 mg, 2.0 mmol) in 10 mL of anhydrous THF was added dropwise a solution of ethyl

4-(4-chlorobenzyl)-1-(2-(3-(ethoxycarbonylmethyl)phenoxy)ethyl)piperidine (0.435

g, 1.10 mmol) in 2 mL of THF at -78°C. The resulting

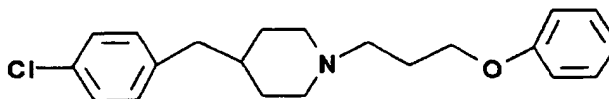
- 89 -

mixture was allowed to warm to room temperature and stirred further for 12 hr. Water (0.2 mL), 15% NaOH aqueous solution (0.2 mL) and water (1 mL) were added successively. The colorless solid was removed through filtration and washed with EtOAc (3 X 20 mL). The filtrate was dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation of solvent gave a residue, which was purified by flash chromatography giving the title product as colorless oil (310 mg, 76%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.34 (m, 2 H), 1.63 (m, 4 H), 1.90 (m, 1 H), 2.07 (m, 2 H), 2.43 (m, 2 H), 2.83 (m, 3 H), 2.98 (m, 2 H), 3.39 (m, 2 H), 4.10 (m, 2 H), 6.78 (m, 3 H), 7.25 (m, 5 H).

## Example 30

15

4-(4-Chlorobenzyl)-1-(3-phenoxypropyl)-  
piperidine hydrobromide



20

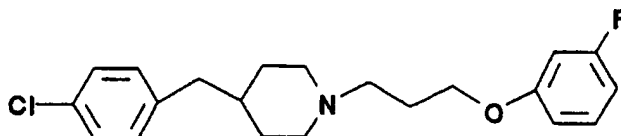
The compound was prepared in a manner similar to example 25. From 4-(4-chlorobenzyl)piperidine hydrochloride (1.00 g, 4.06 mmol) and 3-phenoxypropyl bromide (916 mg, 4.26 mmol, Aldrich) there was obtained the hydrobromide salt as a colorless powder (980 mg, 62%), mp 143.5-145.5°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.65-1.89 (m, 3 H), 2.15 (dd, J<sub>1</sub> = 12 Hz, J<sub>2</sub> = 13 Hz, 2 H), 2.39-2.76 (m, 6 H), 3.12-3.25 (m, 2 H), 3.63 (d, J = 11 Hz, 2 H), 4.05 (t, J = 5.1 Hz, 2 H), 6.80-7.10 (m, 5 H), 7.21-7.31 (m, 4 H), 11.32 (bs, 1 H). Anal. Calcd for C<sub>21</sub>H<sub>27</sub>BrClNO: C, 59.38; H, 6.41; N, 3.30. Found: C, 59.01; H, 6.41; N, 3.17.

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## Example 31

4-(4-Chlorobenzyl)-1-(3-(3-fluorophenoxy)-  
propyl)piperidine hydrobromide

5



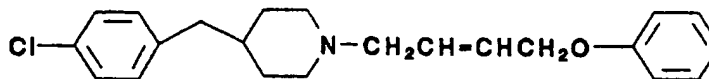
The compound was prepared in a manner similar to example 25. From 4-(4-chlorobenzyl)piperidine hydrochloride (500 mg, 2.03 mmol) and 1-bromo-3-(3-fluorophenoxy)propane (497 mg, 2.13 mmol) there was obtained the hydrobromide salt as a colorless powder (540 mg, 60%): mp 119-122°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.68-2.73 (m, 11 H), 3.10-3.23 (m, 2 H), 3.64 (d, *J* = 11 Hz, 2 H), 4.05 (t, *J* = 5.1 Hz, 2 H), 6.52-6.72 (m, 3 H), 7.03-7.33 (m, 5 H), 11.42 (bs, 1 H). Anal. Calcd for C<sub>21</sub>H<sub>26</sub>ClBrFNO: C, 56.96; H, 5.92; N, 3.16. Found: C, 57.08; H, 6.00; N, 3.15.

20

## Example 32

4-(4-Chlorobenzyl)-1-(4-phenoxybut-2-en-1-yl)-  
piperidine maleic acid salt

25



A) 1-Chloro-4-phenoxybut-2-ene. A mixture of phenol (5.00 g, 53.1 mmol), *cis*-1,4-dichloro-2-butene (27.9 mL, 33.2 g, 266 mmol), K<sub>2</sub>CO<sub>3</sub> (7.71 g, 55.8 mmol) in DMF (30 mL) was stirred at 120°C under N<sub>2</sub>. After 24 h, TLC (10% CHCl<sub>3</sub>/90% hexanes) indicated partial conversion of phenol to a higher *R<sub>f</sub>* product. A crystal of I<sub>2</sub> was added and the reaction was allowed to proceed and additional 24 h. It was worked up to give a yellow liquid (1.00 g, 10%; a mixture of isomers (*cis* and *trans*) by NMR (approximately 9:1 respectively): <sup>1</sup>H NMR (CDCl<sub>3</sub>, major isomer) 4.17 (d, *J* = 6.6 Hz, 2 H), 4.66



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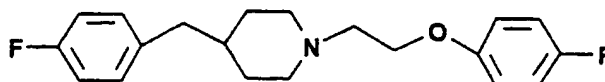
(d,  $J = 4.2$  Hz, 2 H), 5.82-5.98 (m, 2 H), 6.91-7.05 (m, 3 H), 7.27-7.30 (m, 2 H).

B) 4-(4-Chlorobenzyl)-1-(4-phenoxybut-2-en-1-yl)piperidine maleic acid salt. The compound was prepared in a manner similar to example 7. From 4-(4-chlorobenzyl)piperidine hydrochloride (1.35 g, 5.47 mmol) and 1-chloro-4-phenoxybut-2-ene (1.00 g, 5.47 mmol) there was obtained a clear amber oil (933 mg, 48%):  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , major isomer) 1.22-1.68 (m, 5 H), 1.91 (t,  $J = 8.1$  Hz, 2 H), 2.50 (d,  $J = 6.9$  Hz, 2 H), 2.95 (d,  $J = 11$  Hz, 2 H), 3.08 (d,  $J = 6.0$  Hz, 2 H), 4.59 (d,  $J = 5.4$  Hz, 2 H), 5.76-5.92 (m, 2 H, decoupling shows that the 2 olefinic protons have  $J = 12$  Hz), 6.85-7.33 (m, 9 H). The maleic acid salt was prepared according to the following procedure. A solution of the free base (136 mg, 382 mmol) in ether (1 mL) was added to a vigorously stirred solution of maleic acid (250 mg, Aldrich) in ether (10 mL). An oil formed. Additional ether was added (total volume 45 mL) and the mixture was vigorously stirred for 24 h to give a suspension. The solid was collected, washed with ether (6 x 1 mL) and dried in vacuo (0.005 Torr,  $56^\circ\text{C}$ ) to yield a colorless powder (120 mg, 67%; 90% *cis* isomer by NMR): mp  $84-85.5^\circ\text{C}$ ;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.60-1.89 (m, 5 H), 2.48-2.68 (m, 4 H), 3.58 (d,  $J = 12$  Hz, 2 H), 3.80 (d,  $J = 7.2$  Hz, 2 H), 4.59 (d,  $J = 5.4$  Hz, 2 H), 5.77-5.90 (m, 1 H), 6.12-6.24 (m, 1 H), 6.30 (s, 1 H), 6.83-7.36 (m, 10 H), 12.33 (bs, 1 H). Anal. Calcd for  $\text{C}_{26}\text{H}_{30}\text{ClNO}_5$ : C, 66.16; H, 6.41; N, 2.97. Found: C, 65.93; H, 6.28; N, 3.21.

## Example 33

4-(4-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)-  
piperidine hydrochloride

5



A) *N*-Acetylisonipecotic acid. Isonipecotic acid (25.0 g, 0.190 mol) was dissolved in acetic anhydride (100 mL) and the solution stirred at reflux for 8 h, then the solvent was removed under reduced pressure and the crude compound crystallized from MeOH/ether to afford the title compound as a colorless solid (24.4 g, 74%): mp 171°C; <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>) 1.20-1.50 (m, 2H), 1.65-1.85 (m, 2H), 1.94 (s, 3H), 2.35-2.50 (m, 1H), 2.64 (t, *J* = 11.7 Hz, 1H), 3.04 (t, *J* = 11.7 Hz, 1H), 3.69 (d, *J* = 13.5 Hz, 1H), 4.15 (d, *J* = 13.2 Hz, 1H), 12.2 (bs, 1H).

B) *N*-Acetylisonipecotoyl chloride. *N*-acetylisonipecotic acid (0.67 g, 3.9 mmol) was added to SOCl<sub>2</sub> (4.1 mL). The acid chloride precipitated from solution and petroleum ether (60 mL) was added. The mixture was filtered and the residue was washed several times with petroleum ether to afford the title compound as a colorless solid (0.716 g, 97%): mp 133-138°C <sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>) 1.20-1.50 (m, 2H), 1.65-2.00 (m, 2H), 1.94 (s, 3H), 2.30-2.50 (m, 1H), 2.64 (t, *J* = 11.4 Hz, 1H), 3.04 (t, *J* = 11.4 Hz, 1H), 3.69 (d, *J* = 13.2 Hz, 1H), 4.14 (d, *J* = 13.2 Hz, 1H).

C) 1-Acetyl-4-(4-fluorobenzoyl)piperidine. *N*-acetylisonipecotoyl chloride (2.00 g, 10.5 mmol) was slowly added to a stirred mixture of aluminum trichloride (2.80 g, 21.1 mmol) in fluorobenzene (10 mL). After addition was complete, the mixture was refluxed for 1 h. The mixture was poured into ice and the resulting layers were separated. The aqueous layer

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was extracted with  $\text{CH}_2\text{Cl}_2$  (2 x 30 mL), the combined organic phase was dried and was concentrated under reduced pressure to afford the title compound as a pale yellow oil (1.30 g, 50%):  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.50-1.70 (m, 5 1H), 1.70-2.00 (m, 3H), 2.10 (s, 3H), 2.81 (t,  $J = 12.0$  Hz, 1H), 3.15-3.30 (m, 1H), 3.40-3.55 (m, 1H), 3.90 (d,  $J = 13.2$  Hz, 1H), 4.57 (d,  $J = 13.2$  Hz, 1H), 7.14 (t,  $J = 8.4$  Hz, 2H), 7.97 (dd,  $J = 5.7$  and 8.4 Hz, 2H).

10 D) 4-(4-Fluorobenzoyl)piperidine hydrobromide. A solution of 1-acetyl-4-(4-fluoro-benzoyl)piperidine (1.20 g, 4.80 mmol) in HCl (6N, 15 mL) was refluxed for 2 h. The cooled solution was made basic (NaOH) and then extracted with benzene (2 x 40 mL). The collected  
15 organic phase was washed with brine (50 mL), dried and was concentrated under reduced pressure. The free amine was dissolved in HBr (saturated solution in MeOH, 10 mL). The precipitated hydrobromide salt was collected, washed with ether (2 x 4 mL) and dried in  
20 vacuo to afford the title compound as a colorless solid (1.54 g, 98%): mp  $198^\circ\text{C}$ ;  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ ) 1.80-2.00 (m, 2H), 2.05-2.18 (m, 2H), 3.12-3.28 (m, 2H), 3.40-3.50 (m, 2H), 3.70-3.85 (m, 1H), 4.85 (s, 2H), 7.24 (t,  $J = 8.3$  Hz, 2H), 8.10 (dd,  $J = 5.7$  and 8.7 Hz, 2H).

25

E) 4-(4-Fluorobenzyl)piperidine hydrobromide. Triethylsilyl hydride (8.40 mL, 53.0 mmol) was added dropwise to a solution of 4-(4-fluorobenzoyl)piperidine hydrobromide (1.52 g, 5.30 mmol) in trifluoroacetic  
30 acid (30 mL). The resulting solution was allowed to stir for 4 days at  $25^\circ\text{C}$  then the solvent was removed in vacuo. The organic residue was made basic with NaOH (10% solution) and extracted with EtOAc (3 x 50 mL). The collected organic phase was dried and concentrated  
35 under reduced pressure. The crude compound was dissolved in a saturated solution of HBr in MeOH (10 mL) then after 10 min at  $25^\circ\text{C}$  the solution was

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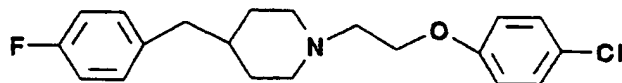
concentrated under reduced pressure. The crude compound was purified by trituration with acetone (10 mL) for 1 h. The solid was collected, washed with acetone (2 x 4 mL) and dried in vacuo to afford the title compound as a colorless solid (0.65 g, 45%): mp 176-180°C; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) 1.20-1.45 (m, 2H), 1.57-1.83 (m, 3H), 2.47 (s, 2H), 2.63-2.85 (m, 2H), 3.10-3.30 (m, 2H), 7.03-7.35 (m, 4H), 8.30 (bs, 1H), 8.55 (bs, 1H).

10 F) 4-(4-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrochloride. The compound was prepared in a manner similar to example 20. From 4-(4-fluorobenzyl)piperidine hydrobromide (600 mg, 2.19 mmol) and 2-(4-fluorophenoxy)ethyl bromide (504 mg, 2.30 mmol) there was obtained the hydrochloride salt as a fluffy, colorless, crystalline solid (315 mg, 40%): mp 153-154°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.55-2.15 (m, 5 H), 2.50-2.83 (m, 4 H), 3.20-3.50 (m, 2 H), 3.66 (d, J = 11 Hz, 2 H), 4.42-4.56 (m, 2 H), 6.76-7.12 (m, 8 H), 12.62 (bs, 1 H). Anal. Calcd for C<sub>20</sub>H<sub>24</sub>ClF<sub>2</sub>NO: C, 65.30; H, 6.58; N, 3.81. Found: C, 65.08; H, 6.79; N, 3.78.

#### Example 34

25

4-(4-Fluorobenzyl)-1-(2-(4-chlorophenoxy)ethyl)piperidine hydrochloride



30

The compound was prepared in a manner similar to example 25. From 4-(4-fluorobenzyl)piperidine hydrobromide (600 mg, 2.19 mmol) and 2-(4-chlorophenoxy)ethyl bromide (542 mg, 2.30 mmol) there was obtained the hydrochloride salt as a fluffy, colorless, crystalline solid (460 mg, 56%): mp 173-174°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.55-2.15 (m, 5 H), 2.50-2.83 (m, 4 H), 3.20-3.50 (m, 2 H), 3.66 (d, J = 11 Hz, 2 H),

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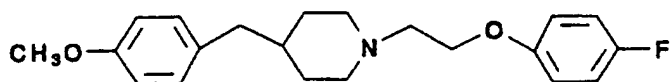
4.45-4.60 (m, 2 H), 6.80 (d,  $J = 9.0$  Hz, 2 H), 6.91-7.12 (m, 4 H), 7.24 (d,  $J = 8.7$  Hz, 2 H), 12.60 (bs, 1 H); Anal. Calcd for  $C_{20}H_{24}Cl_2FNO$ : C, 62.51; H, 6.29; N, 3.64. Found: C, 62.53; H, 6.57; N, 3.63.

5

## Example 35

1-(2-(4-Fluorophenoxy)ethyl)-4-(4-methoxybenzyl)-  
piperidine hydrochloride

10



A) 4-(4-Methoxybenzyl)piperidine. The compound was prepared according to Gray, A. P.; Village, B. and Heitmeier, D. E. (US Patent 3,632,767, 1972) as a colorless, crystalline solid, mp 60-61°C (Lit. 59-61°C).  $^1H$  NMR ( $CDCl_3$ ) 1.02-1.20 (m, 2 H), 1.42-1.68 (m, 4 H), 2.45 (d,  $J = 6.6$  Hz, 2 H), 2.54 (d,  $J = 12$  Hz, 2 H), 3.02 (d,  $J = 12$  Hz, 2 H), 3.78 (s, 3 H), 6.81 (d,  $J = 8.4$  Hz, 2 H), 7.05 (d,  $J = 8.1$  Hz, 2 H).

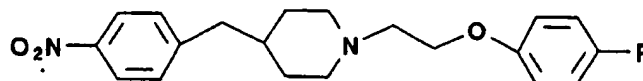
B) 1-(2-(4-Fluorophenoxy)ethyl)-4-(4-methoxybenzyl)piperidine hydrochloride. This compound was prepared in a manner similar to example 25. From 4-(4-methoxybenzyl)piperidine (500 mg, 2.44 mmol) and 2-(4-fluorophenoxy)ethyl bromide (561 mg, 2.56 mmol) there was obtained the hydrochloride salt as colorless plates: mp 171-172°C;  $^1H$  NMR ( $CDCl_3$ ) 1.55-2.18 (m, 5 H), 2.50-2.82 (m, 4 H), 3.25-3.70 (m, 4 H), 3.77 (s, 3 H), 4.50 (t,  $J = 3.6$  Hz, 2 H), 6.75-7.07 (m, 8 H), 12.56 (bs, 1 H). Anal. Calcd for  $C_{21}H_{27}ClFNO_2$ : C, 66.39; H, 7.16; N, 3.69. Found: C, 66.52; H, 7.29; N, 3.68

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## Example 36

1-(2-(4-Fluorophenoxy)ethyl)-4-(4-nitrobenzyl)-  
piperidine hydrobromide

5



A) 4-(2- and 4-Nitrobenzyl)piperidine  
trifluoroacetamide. To stirred, ice bath cold TFAA (5  
10 mL), 4-benzylpiperidine (2.00 g, 11.4 mmol) was added  
dropwise over 10 min. Additional TFAA was added (5 mL)  
and the reaction was stirred 5 min. The ice bath was  
removed and the reaction was allowed to stir an  
additional hour. This was re-cooled in an ice bath and  
15 solid KNO<sub>3</sub> (1.21 g, 12.0 mmol) was added in portions.  
The ice bath was removed and TFA (10 mL) was then  
added. After stirring at 25°C for one hour, the  
reaction mixture was added to ice water (200 mL) to  
give a gummy mixture. This was extracted with CHCl<sub>3</sub> (3  
20 x 75 mL). The extract was washed with water (200 mL),  
saturated NaHCO<sub>3</sub> (200 mL) and water (200 mL), filtered  
through cotton and the solvent removed on a rotoevap to  
give a yellow oil (3.6 g). The mixture was separated  
by chromatography on silica gel to give the ortho  
25 isomer as a pale yellow solid (371 mg, 11%): mp 74.5-  
76.5°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.20-1.40 (m, 2 H), 1.71-2.05 (m,  
3 H), 2.68 (t, J = 13 Hz, 1 H), 2.75-2.95 (m, 2 H),  
3.05 (t, J<sub>1</sub> = 13 Hz, J<sub>2</sub> = 14 Hz, 1 H), 3.98 (d, J = 14  
Hz, 1 H), 4.54 (d, J = 13 Hz, 1 H), 7.27 (d, J = 6.6  
30 Hz, 1 H), 7.40 (t, J = 7.5 Hz, 1 H), 7.54 (t, J = 7.5  
Hz, 1 H), 7.96 (d, J = 7.8 Hz, 1 H); and the para  
isomer as a yellow oil (1.03 g, 29%): <sup>1</sup>H NMR (CDCl<sub>3</sub>)  
1.20-1.40 (m, 2 H), 1.71-1.98 (m, 3 H), 2.60-2.75 (m, 3  
H), 3.06 (t, J<sub>1</sub> = 13 Hz, J<sub>2</sub> = 14 Hz, 1 H), 3.99 (d, J =  
35 14 Hz, 1 H), 4.54 (d, J = 14 Hz, 1 H), 7.30 (d, J = 8.4  
Hz, 2 H), 8.17 (d, J = 8.1 Hz, 2 H).

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B) 4-(4-Nitrobenzyl)piperidine hydrochloride. To a stirred solution of 4-(4-nitrobenzyl)piperidine trifluoroacetamide (1.00 g, 3.16 mmol) in 95% EtOH, a solution of NaOH (500 mg) in water (5 mL) was added. 5 The reaction was allowed to stir at 25°C. After 5 min, The reaction was added to water and extracted with CHCl<sub>3</sub> (3 x 50 mL). The extract was washed with water (100 mL), filtered through cotton and the solvent removed on a rotoevap to give a yellow oil. The oil was dissolved 10 in MeOH (5 mL) and concd HCl was added until the amine solution was permanently acidic. The solvent was removed on a rotoevap and the resulting solid was dried on a rotoevap at 70°C (750 mg, 92%): mp 191-194°C. <sup>1</sup>H NMR (D<sub>2</sub>O) 1.35-1.57 (m, 2 H), 1.78-2.05 (m, 3 H), 2.71 15 (d, *J* = 6.9 Hz, 2 H), 2.94 (t, *J* = 13 Hz, 2 H), 3.40 (d, *J* = 13 Hz, 2 H), 7.39 (d, *J* = 8.4 Hz, 2 H), 8.10 (d, *J* = 8.4 Hz, 2 H).

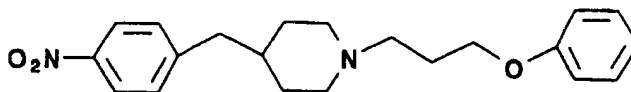
C) 1-(2-(4-Fluorophenoxy)ethyl)-4-(4-nitrobenzyl)piperidine hydrobromide. This compound was 20 prepared in a manner similar to example 25. From 4-(4-nitrobenzyl)piperidine hydrochloride (427 mg, 1.66 mmol) and 2-(4-fluorophenoxy)ethyl bromide (381 mg, 1.74 mmol) there was obtained the hydrobromide salt as 25 a pale beige powder (510 mg, 94%): mp 147-148°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.65-1.89 (m, 3 H), 2.20 (q, *J* = 12 Hz, 2 H), 2.69-2.90 (m, 4 H), 3.35-3.45 (m, 2 H), 3.73 (d, *J* = 12 Hz, 2 H), 4.55 (t, *J* = 3.6 Hz, 2 H), 6.77-7.04 (m, 4 H), 7.30 (d, *J* = 8.4 Hz, 2 H), 8.16 (d, *J* = 8.4 Hz, 2 30 H), 11.75 (bs, 1 H). Anal. Calcd for C<sub>20</sub>H<sub>24</sub>BrFN<sub>2</sub>O<sub>3</sub>: C, 54.68; H, 5.51; N, 6.38. Found: C, 54.67; H, 5.36; N, 6.29.

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## Example 37

4-(4-Nitrobenzyl)-1-(3-phenoxypropyl)-  
piperidine hydrobromide

5



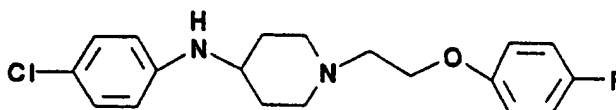
This compound was prepared in a manner similar to example 10. From 4-(4-nitrobenzyl)piperidine hydrochloride (250 mg, 974  $\mu$ mol) and 3-phenoxypropyl bromide (219 mg, 1.02 mmol) there was obtained the hydrobromide salt as a beige powder (289 mg, 94%): mp 148-150°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.78-2.82 (m, 11 H), 3.12-3.26 (m, 2 H), 3.66 (d,  $J$  = 11 Hz, 2 H), 4.07 (t,  $J$  = 5.1 Hz, 2 H), 6.84 (d,  $J$  = 8.1 Hz, 2 H), 6.96 (t,  $J$  = 7.5 Hz, 1 H), 7.23-7.35 (m, 4 H), 8.16 (d,  $J$  = 8.4 Hz, 2 H), 11.40 (bs, 1 H). Anal. Calcd for  $\text{C}_{21}\text{H}_{27}\text{BrN}_2\text{O}_3$ : C, 57.94; H, 6.25; N, 6.43. Found: C, 57.72; H, 6.11; N, 6.15.

20

## Example 38

4-(4-Chloroanilino)-1-(2-(4-fluorophenoxy)-  
ethyl)piperidine dihydrochloride

25



A) 1-(2-(4-Fluorophenoxy)ethyl)-4-piperidone. This compound was prepared in a manner similar to example 7. From 4-piperidone monohydrate hydrochloride (2.50 g, 16.3 mmol), 2-(4-fluorophenoxy)ethyl bromide (3.74 g, 17.1 mmol) there was obtained the amine as a pale yellow liquid which crystallized upon agitation (3.39 g, 88%): mp 71-73°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 2.48 (t,  $J$  = 6.0 Hz, 4 H), 2.85-2.97 (m, 6 H), 4.10 (t,  $J$  = 5.4 Hz, 2 H), 6.80-7.03 (m, 4 H).

35



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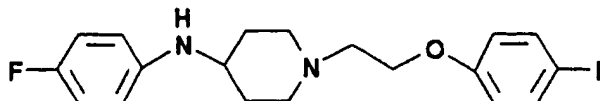
B) 4-(4-Chloroanilino)-1-(2-(4-fluorophenoxy)ethyl)piperidine dihydrochloride. To a stirred solution of 1-(2-(4-fluorophenoxy)ethyl)-4-piperidone (1.00 g, 4.21 mmol) in MeOH (10 mL) there were added 4-chloroaniline (1.61 g, 12.6 mmol) and NaCNBH<sub>3</sub> (787 mg, 12.6 mmol). The resulting solution was allowed to stir at 25°C under N<sub>2</sub> for 5 d. A brown solution was present. The reaction was added to 10% HCl (100 mL) and was allowed to stir at 25°C for 20 min in order to allow the excess reducing agent to decompose. The resulting mixture was washed with ether (3 x 50 mL). The ether was back extracted with 10% HCl (25 mL). The combined acid portion was made basic (pH 8) with an NaOH solution. The basic solution was extracted with ether (3 x 50 mL). The ether extract was washed with saturated NaCl (50 mL), filtered through cotton and the ether removed on a rotoevap to give a colorless oil. This was purified chromatographically on silica gel (2.5 x 30 cm). CHCl<sub>3</sub> elution removed the unreacted 4-chloroaniline. Elution with 2% EtOH/98% CHCl<sub>3</sub> gave the product as a pale orange solid (398 mg, 27%): mp 66-71°C; The hydrochloride salt was obtained as a pale yellow solid (340 mg, 72%): mp 199-207°C (dec); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) 1.85-2.20 (m, 4 H), 3.00-3.80 (m, 7 H), 4.39 (t, J = 3.9 Hz, 2 H), 6.92-7.36 (m, 10 H), 11.15 and 11.23 (overlapping bs, 1 H). Anal. Calcd for C<sub>19</sub>H<sub>24</sub>Cl<sub>2</sub>FN<sub>2</sub>O: C, 54.11; H, 5.74; N, 6.64. Found: C, 54.21; H, 5.78; N, 6.54.

30

## Example 39

1-(2-(4-Fluorophenoxy)ethyl)-4-(N-(4-fluoroanilino)-piperidine hydrochloride

35



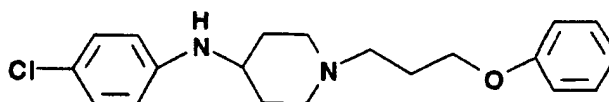
This compound was prepared in a manner similar to example 38. From 1-(2-(4-fluorophenoxy)ethyl)-4-

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piperidone (2.20 g, 9.27 mmol), 4-fluoroaniline (3.09 g, 27.8 mmol, Aldrich) and NaCNBH<sub>3</sub> (1.15 g, 18.5 mmol) there was obtained the hydrochloride as a pale beige solid (903 mg, 24%): mp 173-178°C (dec); <sup>1</sup>H NMR (DMSO-  
 5 d<sub>6</sub>) 1.75-2.20 (m, 4 H), 3.00-3.70 (m, 7 H), 4.39 (bs, 2 H), 6.70-7.20 (m, 9 H), 11.05 (bs, 1 H); <sup>1</sup>H NMR (CD<sub>3</sub>OD) δ 2.00-2.38 (m, 4 H), 3.18-3.80- (m, 7 H), 4.39 (t, J = 4.5 Hz), 6.90-7.32 (m, 8 H). Anal. Calcd for C<sub>19</sub>H<sub>23</sub>ClF<sub>2</sub>N<sub>2</sub>O · 0.14 H<sub>2</sub>O: C, 61.45; H, 6.32; N, 7.54. Found: C,  
 10 61.10; H, 5.92; N, 7.36.

## Example 40

15 4-(N-(4-Chloroanilino)-1-(3-phenoxypropyl)-  
 piperidine hydrobromide



A) 1-(3-Phenoxypropyl)-4-piperidone. This compound  
 20 was prepared in a manner similar to example 7. From 4-piperidone monohydrate hydrochloride (3.07 g, 20.0 mmol) and 3-phenoxypropyl bromide (4.52 g, 21.0 mmol) there was obtained the amine as a pale yellow liquid (1.48 g, 32%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.03 (p, J = 6.6 Hz, 2  
 25 H), 2.46 (t, J = 5.7 Hz, 4 H), 2.66 (t, J = 6.9 Hz, 2 H), 2.78 (t, J = 6.0 Hz, 4 H), 4.06 (t, J = 6.0 Hz, 2 H), 6.88-6.99 (m, 3 H), 7.29 (t, J<sub>1</sub> = 8.1 Hz, J<sub>2</sub> = 7.5 Hz, 2 H).

30 B) 4-(N-(4-Chloroanilino)-1-(3-phenoxypropyl)piperidine hydrobromide. This compound was prepared in a manner similar to example 38. From 1-(3-phenoxypropyl)-4-piperidone (1.47 g, 6.30 mmol), 4-chloroaniline (804 mg, 6.30 mmol) and NaCNBH<sub>3</sub> (1.31 g, 21 mmole) there was obtained the hydrobromide salt as a colorless solid (450 mg, 14%), mp 193-195°C (dec); <sup>1</sup>H  
 35 NMR (DMSO-d<sub>6</sub>) 1.60-2.25 (m, 6 H), 3.00-3.65 (m, 7 H),

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4.04 (t,  $J = 5.7$  Hz, 2 H), 6.62-6.70 (m, 2 H), 6.83-6.97 (m, 3 H), 7.10 (d,  $J = 8.7$  Hz, 2 H), 7.28 (t,  $J_1 = 7.8$  Hz,  $J_2 = 7.5$  Hz, 2 H), 9.64 (bs, 1 H). Anal. Calcd for  $C_{20}H_{26}BrClN_2O \cdot 0.40 H_2O$ : C, 55.47; H, 6.24; N, 6.46. Found: C, 55.64; H, 6.07; N, 6.37.

A General procedure for reaction of piperidine  
with alkyl chloride or bromide

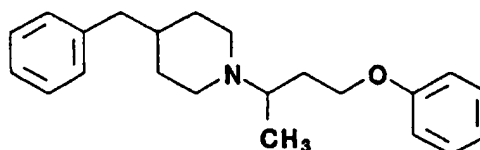
10 A mixture of a free base of piperidine derivative and an alkyl chloride or bromide in toluene in the presence of NaI was refluxed for 1-10 h. The reaction mixture was cooled to r.t, filtered and washed with hexane. The filtrate was evaporated, and the residue was  
15 chromatographed over silica gel to give the product. If the product is a solid, it was crystallized from hexane or hexane-ethyl acetate. If the product is an oil, it was dissolved in acetone and 4N HCl solution in 1,4-dioxane or conc. HCl was added until the mixture  
20 became strong acidic (pH < 2). It was rota-evaporated, and co-evaporated until a solid residue was obtained, then the solid was recrystallized from acetone to give the hydrochloride.

25

## Example 41

4-Benzyl-1-(1-methyl-3-phenoxypropyl)-  
piperidine hydrochloride

30



A) 1-Methyl-3-phenoxypropyl chloride. A mixture of phenol (1.546 g, 16.4 mmol) and NaOH (644 mg, 16.1 mmol) in ethanol (25 mL) was refluxed until a solution  
35 was formed (about 20 min) and it was cooled to room temperature. To the resulting solution was added 1,3-dichlorobutane (2.124 g, 16.7 mmol) and it was refluxed for 18 h, cooled to room temperature and evaporated.

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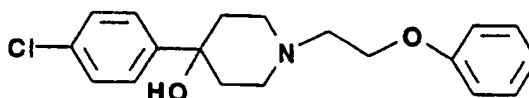
The residue was extracted with ethyl acetate (3 x 20 mL) and the extract was washed with brine, dried (MgSO<sub>4</sub>) and evaporated. The residual oil was repeatedly (3 times) chromatographed over silica gel (hexane-EtOAc, 95 : 5) to give 554 mg of a yellow oil, which contained about 80% of the desired product by <sup>1</sup>H NMR and was used for the next reaction without further purification.

B) 4-Benzyl-1-(1-methyl-3-phenoxypropyl)piperidine hydrochloride. From the above crude 1-methyl-3-phenoxypropyl chloride (520 mg, 2.2 mmol) and 4-benzylpiperidine (750 mg, 4.23 mmol) there was obtained 220 mg (31%) of the amine as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>), 1.299 (d, 3H, J=6), 1.48-1.55 (m, 1H), 1.61-1.92 (m, 7H), 2.35-2.48 (m, 3H), 2.528 (d, 2H, J=7.7), 2.85-2.92 (m, 2H), 4.417 (q, 1H, J=6), 6.88-6.93 (m, 2H), 7.13-7.29 (m, 8H). The hydrochloride, mp 177-8°C. Anal. Calcd. for C<sub>22</sub>H<sub>30</sub>ClNO: C 73.41, H 8.40, N 3.89; Found: C 73.35, H 8.48, N 3.66.

20

Example 42  
4-(4-Chlorophenyl)-4-hydroxyl-1-(2-phenoxyethyl)-piperidine hydrochloride

25



From β-bromophenetole (201 mg, 1.0 mmol) and 4-(4-chlorophenyl)-4-hydroxypiperidine (212 mg, 1.0 mmol) there was obtained 110 mg (51%) of the amine as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.65-1.76 (m, 4H), 2.12-2.22 (m, 2H), 2.59-2.66 (m, 2H), 2.88-2.95 (m, 3H), 4.155 (t, 2H, J=5.8), 6.91-6.98 (m, 3H), 7.29-7.33 (m, 3H), 7.44-7.47 (m, 3H). The hydrochloride, mp 197-8°C. Anal. Calcd. for C<sub>19</sub>H<sub>23</sub>Cl<sub>2</sub>NO<sub>2</sub>: C 61.96, H 6.29, N 3.80; Found: C 61.69, H 6.13, N 3.69.

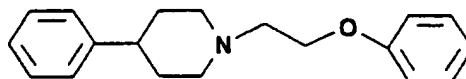
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## Example 43

## 1 - (2-Phenoxyethyl) - 4-phenylpiperidine hydrochloride

5



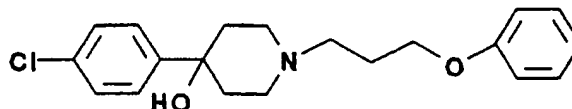
From  $\beta$ -bromophenetole (65 mg, 0.32 mmol) and 4-phenylpiperidine (105 mg, 0.65 mmol) there was obtained 120 mg (65%) of the amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.80-1.85 (m, 4H), 2.12-2.30 (m, 2H), 2.48-2.59 (m, 1H), 2.873 (t, 2H,  $J=5.8$ ), 3.13-3.17 (m, 2H), 4.155 (t, 2H,  $J=5.8$ ), 6.91-6.98 (m, 4H), 7.20-7.35 (m, 6H). The hydrochloride, mp 165-6°C.

15

## Example 44

## 4 - (4-Chlorophenyl) - 4-hydroxy-1 - (3-phenoxypropyl) - piperidine

20

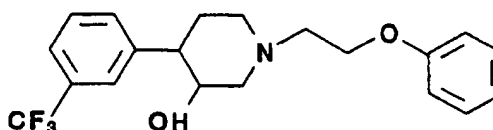


From 3-phenoxypropyl bromide (260 mg, 1.2 mmol) and 4-(4-chlorophenyl)-4-hydroxypiperidine (514 mg, 2.4 mmol) there was obtained 266 mg (63.6%) of the amine as a yellowish powder, mp 125-6°C.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.56 (bs, 1H), 1.72-1.76 (m, 2H), 1.98-2.18 (m, 4H), 2.42-2.49 (m, 2H), 2.58-2.63 (m, 2H), 2.83-2.87 (m, 2H), 4.040 (t, 2H,  $J=6$ ), 6.90-6.96 (m, 3H), 7.28-7.33 (m, 4H), 7.44-7.47 (d, 2H,  $J=8.5$ ). Anal. Calcd. for  $\text{C}_{20}\text{H}_{24}\text{ClNO}_2$ : C 69.45, H 6.99, N 4.05; Found: C 69.41, H 7.03, N 4.07.

35

## Example 45

## 3-Hydroxy-1-(2-phenoxyethyl)-4-(3-trifluoromethylphenyl) piperidine hydrochloride

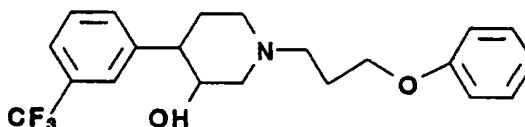


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From  $\beta$ -bromophenetole (183 mg, 0.91 mmol) and 3-hydroxy-4-(3-trifluoromethylphenyl)piperidine (450 mg, 1.84 mmol) there was obtained 270 mg (81%) of the amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.66 - 1.79 (m, 3H), 1.95-2.27 (m, 2H), 2.61-2.69 (m, 2H), 2.90-2.98 (m, 4H), 4.171 (t, 2H,  $J=5.7$ ), 6.91-6.98 (m, 3H), 7.26-7.32 (m, 2H), 7.44-7.60 (m, 2H), 7.68-7.71 (d, 1H,  $J=7.7$ ), 7.81 (s, 1H). The hydrochloride, mp 150-51°C. Anal. Calcd. for  $\text{C}_{20}\text{H}_{23}\text{ClF}_3\text{NO}_2$ : C 59.78, H 5.77, N 3.49; Found: C 59.67, H 5.69, N 3.40.

## Example 46

15 3-Hydroxy-1-(3-phenoxypropyl)-4-(3-trifluoromethylphenyl)piperidine hydrochloride

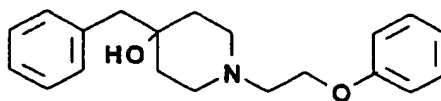


From 3-phenoxypropyl bromide (184 mg, 0.86 mmol) and 4-(3-trifluoromethylphenyl)-3-piperidinol (420 mg, 1.71 mmol) there was obtained 216 mg (67%) of the amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.62-1.78 (m, 3H), 2.00-2.08 (m, 2H), 2.17-2.25 (m, 2H), 2.47-2.54 (m, 2H), 2.649 (t, 2H,  $J=7$ ), 2.89-2.92 (m, 2H), 4.048 (t, 2H,  $J=6$ ), 6.90-6.97 (m, 3H), 7.26-7.32 (m, 2H), 7.44-7.60 (m, 2H), 7.69 (d, 1H,  $J=7.7$ ), 7.81 (s, 1H). The hydrochloride, mp 176-8°C. Anal. Calcd. for  $\text{C}_{21}\text{H}_{25}\text{ClF}_3\text{NO}_2$ : C 60.65, H 6.06, N 3.37; Found: C 60.65, H 6.01, N 3.25.

30

## Example 47

35 4-Benzyl-4-hydroxy-1-(2-phenoxyethyl)piperidine hydrochloride



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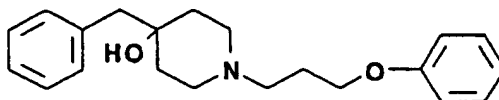
From  $\beta$ -bromophenetole (303 mg, 1.5 mmol) and 4-benzyl-4-hydroxypiperidine (607 mg, 3.05 mmol) there was obtained 320 mg (68%) of the amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.198 (bs, 1H, OH), 1.52-1.56 (m, 2H), 1.67-1.83 (m, 4H), 2.41-2.49 (m, 2H), 2.76-2.84 (m, 4H), 4.105 (t, 2H,  $J=6$ ), 6.89-6.96 (m, 3H), 7.19-7.34 (m, 7H). The hydrochloride, mp 175-6°C. Anal. Calcd. for  $\text{C}_{20}\text{H}_{26}\text{ClNO}_2$ : C 69.05, H 7.53, N 4.03; Found: C 69.00, H 7.55, N 3.96.

10

## Example 48

## 4-Benzyl-4-hydroxy-1-(3-phenoxypropyl)piperidine

15



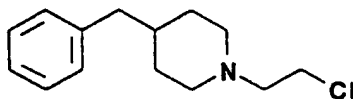
From 3-phenoxypropyl bromide (338 mg, 1.57 mmol) and 4-benzyl-4-hydroxypiperidine (628 mg, 3.16 mmol) there was obtained 320 mg (62%) of the amine as a yellowish powder, mp 87-8°C.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.200 (bs, 1H), 1.52-1.56 (m, 2H), 1.71-1.81 (m, 2H), 1.96-2.05 (m, 2H), 2.29-2.36 (m, 2H), 2.546 (t, 2H,  $J=7$ ), 2.68-2.72 (m, 2H), 2.764 (s, 2H), 4.00 (t, 2H,  $J=6$ ), 6.88-6.95 (m, 3H), 7.19-7.34 (m, 7H). Anal. Calcd. for  $\text{C}_{21}\text{H}_{27}\text{NO}_2$ : C 77.50, H 8.36, N 4.30; Found: 77.06, H 8.39, N 4.04.

25

## Example 49

## 4-Benzyl-1-(2-chloroethyl)piperidine

30



From 1-bromo-2-chloroethane (14.35 g, 0.1 mol) and 4-benzylpiperidine (17.53 g, 0.1 mol) there was obtained 2.5 g (11%) of the title compound as a yellowish oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.25-1.38 (m, 2H), 1.45-1.57 (m, 1H), 1.61-1.66 (m, 2H), 1.96-2.05 (m, 2H), 2.537 (d, 2H,  $J=7$ ), 2.690 (t, 2H,  $J=7$ ), 2.87-2.91 (m, 2H), 3.574 (t,

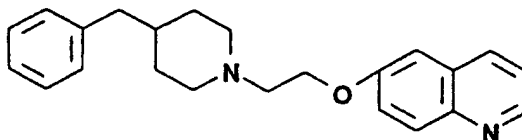
35

2H, J=7), 7.12-7.30 (m, 5H). It was used without further purification.

## Example 50

5

## 4-Benzyl-1-[2-(6-quinolinoxy)ethyl]piperidine

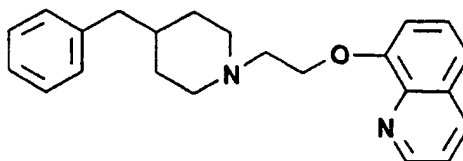


10 A mixture of NaOH (58 mg, 1.45 mmol), 6-hydroxyquinoline (204 mg, 1.4 mmol) in EtOH (15 mL) was refluxed for 0.5 h. The resulting solution was cooled to r.t, and 4-benzyl-1-(2-chloroethyl)piperidine (615 mg, 2.8 mmol) was added. It was refluxed for 16 h,  
15 cooled to r.t, and filtered. The filtrate was evaporated, and the residue was chromatographed over silica gel (EtOAc : EtOH, 7 : 3) to give 305 mg (71%) of the amine as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.34-1.47 (m, 2H), 1.50-1.63 (m, 1H), 1.66-1.71 (m 2H),  
20 2.10-2.18 (m, 2H), 2.558 (d, 2H, J=7), 2.897 (t, 2H, J=6), 3.04-3.08 (m, 2H), 4.255 (t, 2H, J=6), 7.07-7.39 (m, 8H). 7.989 (d, 1H, J=9), 8.01-8.05 (m, 1H), 8.758 (dd, 1H, J=4; 1.2). The hydrochloride, mp 202-204 °C. Anal. Calcd. for (C<sub>23</sub>H<sub>26</sub>N<sub>2</sub>O + 2HCl) : C 65.87, H 6.73, N  
25 6.68; Found: C 65.78, H 6.65, N 6.58.

## Example 51

30

## 4-Benzyl-1-[2-(8-quinolinoxy)ethyl]piperidine



The compound was prepared in a manner similar to example 50. From 8-hydroxyquinoline (330 mg, 2.27  
35 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (423 mg, 1.92 mmol) there was obtained 284 mg (43.6%) of the



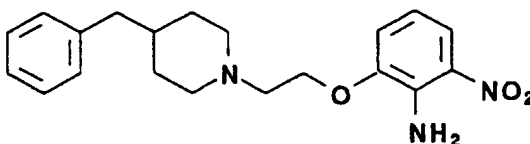
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amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.36-1.44 (m, 2H), 1.50-1.60 (m, 1H), 1.65-1.69 (m, 2H), 2.08-2.15 (m, 2H), 2.545 (d, 2H,  $J=7$ ), 3.00-3.07 (m, 4H), 4.371 (t, 2H,  $J=7$ ), 7.13-7.47 (m, 9H), 8.11-8.14 (m, 1H), 8.92-8.94 (m, 1H). Anal. for the hydrochloride, Calcd. for ( $\text{C}_{22}\text{H}_{26}\text{N}_2\text{O} + 2\text{HCl} + \text{H}_2\text{O}$ ): C 63.16, H 6.91, N 6.40; Found: C 63.16, H 7.13, N 6.26.

## Example 52

10

4-Benzyl-1-[2-(2-amino-3-nitrophenoxy)ethyl]-piperidine



15

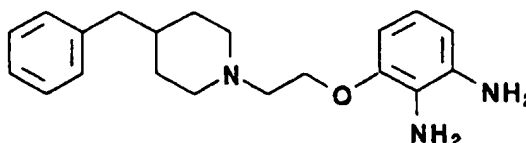
The compound was prepared in a manner similar to example 50. From 2-amino-3-nitrophenol (310 mg, 2.0 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (445 mg, 2.0 mmol) there was obtained 590 mg (89.6%) of the amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.25-1.37 (m, 2H), 1.50-1.60 (m, 1H), 1.65-1.70 (m, 2H), 2.02-2.10 (m, 2H), 2.554 (d, 2H,  $J=7$ ), 2.768 (t, 2H,  $J=5.5$ ), 2.94-2.98 (m, 2H), 4.110 (t, 2H,  $J=5.5$ ), 6.570 (t, 1H,  $J=8$ ), 6.750 (bs, 2H), 6.947 (d, 1H,  $J=8$ ), 7.14-7.31 (m, 5H). 7.770 (d, 1H,  $J=8$ ).

25

## Example 53

30

4-Benzyl-1-[2-(2,3-diaminophenoxy)ethyl]-piperidine



A mixture of the nitro compounds (580 mg, 76 mmol), 5% Pd/C (70 mg) and EtOH (20 mL) was shaken under  $\text{H}_2$  (30 psi) for 2 h. The mixture was filtered, and the

35

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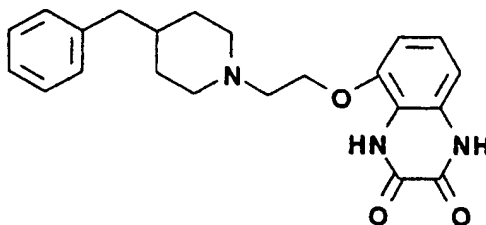
filtrate was evaporated to give 478 mg (90%) of the diamine as a yellow powder, mp 88-90°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.35-1.43 (m, 2H), 1.50-1.60 (m, 1H), 1.65-1.69 (m, 2H), 2.06-2.14 (m, 2H), 2.552 (d, 2H, J=7), 2.813 (t, 2H, J=6), 3.00-3.04 (m, 2H), 3.420 (bs, 4H), 4.131 (t, 2H, J=6), 6.39-6.42 (m, 2H), 6.636 (t, 1H, J=8), 7.13-7.30 (m, 5H). Anal. Calcd. for C<sub>20</sub>H<sub>27</sub>N<sub>3</sub>O: C, 73.81, H, 8.36, N, 12.91; Found: C, 74.02, H, 8.27, N, 12.70.

10

## Example 54

## 4-Benzyl-1-[2-(2,3-dioxoquinoxalin-5-oxy)-ethyl]piperidine

15



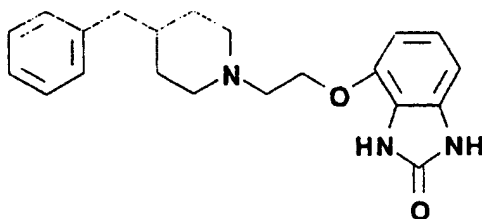
A solution of the diamine (465 mg, 1.55 mmol) and oxalic acid (270 mg, 3.0 mmol) in 2N HCl (10 mL) was refluxed for 3 h, then cooled to r.t. The mixture was neutralized to pH 7 with 1N aq NaOH. The mixture was heated to boil with stirring, then cooled to r.t. The precipitate was filtered, washed with H<sub>2</sub>O (3 x 5 mL) and dried. The dry brown solid was stirred vigorously with EtOAc (10 mL) for 0.5 h at r.t, then filtered, washed with EtOAc (2 x 5 mL), and dried to give 352 mg (60%) of the title compound as a cream powder, mp 244-5°C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.27-1.34 (m, 2H), 1.50-1.54 (m, 3H), 1.961 (t, 2H, J=10.6), 2.500 (d, 2H, J=5.5), 2.678 (t, 2H, J=5.5), 2.90-2.94 (m, 2H), 4.115 (t, 2H, J=5.5), 6.775 (d, 1H, J=8), 6.834 (d, 1H, J=8), 7.020 (t, 1H, J=8), 7.14-7.30 (m, 5H), 11.87 (bs, 2H). Anal. Calcd. for (C<sub>22</sub>H<sub>23</sub>N<sub>3</sub>O<sub>3</sub> + 0.25H<sub>2</sub>O) : C, 68.82, H, 6.69, N, 10.94; Found: C, 68.76, H, 6.42, N, 10.83.

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## Example 55

## 4-Benzyl-1-[2-(2-oxobenzimidazol-4-oxo)-ethyl]piperidine

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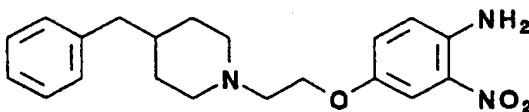


A solution of the diamine (150 mg, 0.5 mmol), 1,1'-carbonyldiimidazole (CDI, 100 mg, 0.62 mmol) in toluene  
10 (5 mL) was refluxed under N<sub>2</sub> for 18 h, then evaporated. The residual solid was dissolved in EtOAc (20 mL) and washed with H<sub>2</sub>O (3 x 10 mL). The EtOAc solution was evaporated, and the residual solid was heated with 15 mL of hexane-ethyl acetate (10 : 1) to boil, then  
15 cooled to rt. The precipitate was filtered, and dried to give 122 mg (69%) of the title compound as a cream powder, mp 153-4 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.56-1.70 (m, 4H), 2.00-2.12 (m, 3H), 2.613 (d, 2H, J=5), 2.728 (t, 2H, J=5), 3.043 (d, 2H, J=10.5), 4.164 (t, 2H, J=5), 6.655  
20 (d, 1H, J=8), 6.748 (d, 1H, J=8), 6.918 (t, 1H, J=8), 7.16-7.30 (m 5H), 9.199 (s, 1H), 10.856 (s, 1H).

## Example 56

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## 4-Benzyl-1-[2-(4-amino-3-nitrophenoxy)-ethyl]piperidine



30 This compound was prepared in a manner similar to example 50. From 4-amino-3-nitrophenol (306 mg, 2.0 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (440 mg, 2.0 mmol) there was obtained 450 mg of the amine as a yellowish powder, mp 89-90°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.30-1.41  
35 (m, 2H), 1.50-1.55 (m, 1H), 1.62-1.67 (m 2H), 2.96-2.07

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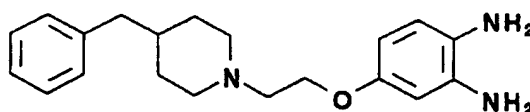
(m, 2H), 2.535 (d, 2H, J=7), 2.757 (t, 2H, J=7), 2.95-2.99 (m, 2H), 4.054 (t, 2H, J=7), 5.868 (bs, 2H), 6.739 (d, 1H, J=9), 7.080 (dd, 1H, J=9; 3), 7.13-7.30 (m, 5H), 7.560 (d, 1H, J=3).

5

## Example 57

4-Benzyl-1-[2-(3,4-diaminophenoxy)-ethyl]piperidine

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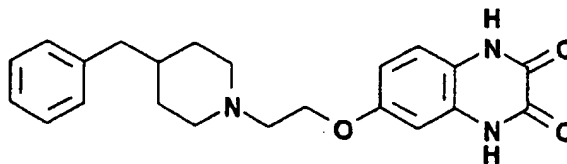


The hydrogenation of the nitro compound (500 mg, 1.40 mmol) was carried out under the same condition as that for example 53, followed by crystallization from hexane to give the diamine (296 mg, 65%) as a yellowish crystalline solid, mp 78-9°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.26-1.39 (m, 2H), 1.45-1.57 (m, 1H), 1.61-1.65 (m, 2H), 1.98-2.06 (m, 2H), 2.530 (d, 2H, J=7), 2.727 (t, 2H, J=6), 2.94-3.10 (m, 3H), 3.495 (bs, 2H), 4.003 (t, 2H, J=6), 6.245 (dd, 1H, J=8; 2.5), 6.317 (d, 1H, J=2.5), 6.612 (d, 1H, J=8), 7.12-7.29 (m, 5H).

25

## Example 58

4-Benzyl-1-[2-(2,3-dioxoquinoxalin-6-oxy)-ethyl]piperidine



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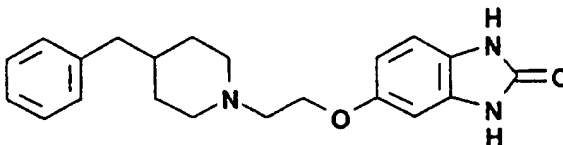
This compound was prepared in a manner similar to example 54. From the diamine (104 mg, 0.32 mmol) and oxalic acid (50 mg, 0.55 mmol) there was obtained the title compound as a cream powder, mp 176-180°C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.27-1.34 (m, 2H), 1.50-1.54 (m, 3H), 1.961 (t, 2H, J=10.6), 2.500 (d, 2H, J=5.5), 2.678 (t, 2H,

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J=5.5), 2.90-2.94 (m, 2H), 4.115 (t, 2H, J=5.5), 6.775 (d, 1H, J=8), 6.834 (d, 1H, J=8), 7.020 (t, 1H, J=8), 7.14-7.30 (m, 5H), 11.87 (bs, 2H). Anal. For the hydrochloride, Calcd. for ( $C_{22}H_{25}N_3O_3 + 1.4 \text{ HCl}$ ) : C, 56.138, H, 6.18, N, 9.76; Found: C, 61.51, H, 5.85, N, 9.77.

## Example 59

10            4-Benzyl-1-[2-(2-oxobenzimidazol-5-oxy)-ethyl]piperidine

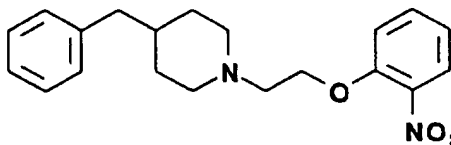


15 This compound was prepared in a manner similar to example 55. From the diamine (148 mg, 0.46 mmol) and CDI (88 mg, 0.54 mmol) there was obtained 144 mg (92%) of the title compound as an off-white powder, mp 224-5°C.  $^1\text{H}$  NMR ( $\text{DMSO}-d_6$ ): 1.16-1.24 (m, 2H), 1.40-1.54 (m, 20 3H), 1.90-1.97 (m, 2H), 2.487 (d, 2H, J=7), 2.610 (t, 2H, J=6), 2.86-2.90 (m, 2H), 3.968 (t, 2H, J=6), 6.48-6.51 (m, 2H), 6.770 (d, 1H, J=9), 7.14-7.29 (m 5H), 10.355 (s, 1H), 10.485 (s, 1H).

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## Example 60

4-Benzyl-1-[2-(2-nitrophenoxy)ethyl]piperidine



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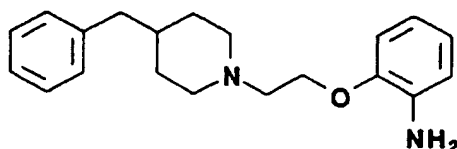
This compound was prepared in a manner similar to example 50. From 2-nitrophenol (200 mg, 1.44 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (320 mg, 1.45 mmol) there was obtained 340 mg (72.6%) of the amine 35 as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.24-1.37 (m, 2H), 1.49-1.59 (m, 1H), 1.63-1.67 (m, 2H), 2.05-2.13

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(m, 2H), 2.535 (d, 2H, J=7), 2.835 (t, 2H, J=5.5), 2.95-2.99 (m, 2H), 4.230 (t, 2H, J=5.5), 7.00-7.30 (m, 7H), 7.510 (t, 1H, J=8), 7.820 (d, 1H, J=8). Anal. for the hydrochloride, Calcd. for (C<sub>20</sub>H<sub>24</sub>N<sub>2</sub>O<sub>3</sub> +1.45 HCl) : C 5 60.77, H 6.49, N 7.09; Found: C 61.05, H 6.53, N 7.07.

Example 61  
4-Benzyl-1-[2-(2-aminophenoxy)ethyl]piperidine

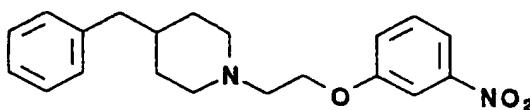
10



The nitro compound (310 mg, 0.9 mmol) was hydrogenated (Pd/C/H<sub>2</sub>) to give 275 mg (97%) of the amine as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.29-1.40 (m, 2H), 1.50-15 1.60 (m, 1H), 1.65-1.69 (m, 2H), 2.04-2.12 (m, 2H), 2.553 (d, 2H, J=7), 2.800 (t, 2H, J=6), 3.00-3.03 (m, 2H), 3.910 (bs, 2H), 4.128 (t, 2H, J=6), 6.67-6.82 (m, 2H), 7.13-7.31 (m, 5H). Anal. for the hydrochloride, Calcd. for (C<sub>22</sub>H<sub>26</sub>N<sub>2</sub>O +2.5HCl): C 61.22, H 7.45, N 7.14; 20 Found: C 61.05, H 7.53, N 6.78.

Example 62  
4-Benzyl-1-[2-(3-nitrophenoxy)ethyl]piperidine

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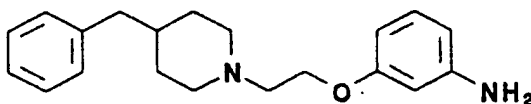
The compound was prepared in a manner similar to example 60 and obtained as a yellow viscous oil. <sup>1</sup>H NMR 30 (CDCl<sub>3</sub>): 1.28-1.41 (m, 2H), 1.49-1.67 (m, 3H), 2.12-2.10 (m, 2H), 2.543 (d, 2H, J=7), 2.801 (t, 2H, J=6), 2.95-3.00 (m, 2H), 4.157 (t, 2H, J=6), 7.13-7.30 (m, 6H), 7.410 (t, 1H, J=8), 7.430 (bs, 1H), 7.806 (d, 1H, J=8).

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## Example 63

## 4-Benzyl-1-[2-(3-aminophenoxy)ethyl]piperidine

5

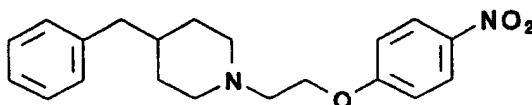


The compound was prepared in a manner similar to example 61 and obtained as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.35-1.45 (m, 2H), 1.64-1.68 (m, 3H), 1.64-1.68 (m, 2H), 2.01-2.14 (m, 2H), 2.548 (d, 2H, J=6.5), 2.807 (t, 2H, J=5.5), 3.00-3.04 (m, 2H), 3.64 (bs, 2H), 4.093 (t, 2H, J=5.5), 6.24 (bs, 1H), 6.27-6.31 (m, 1H), 7.036 (t, 1H, J=8), 7.13-7.30 (m, 5H).

15

## Example 64

## 4-Benzyl-1-[2-(4-nitrophenoxy)ethyl]piperidine



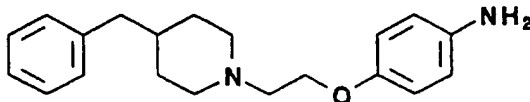
20

The compound was prepared in a manner similar to example 60 and obtained as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.26-1.39 (m, 2H), 1.49-1.58 (m, 1H), 1.61-1.67 (m, 2H), 2.02-2.09 (m, 2H), 2.540 (d, 2H, J=7), 2.800 (t, 2H, J=6), 2.94-2.99 (m, 2H), 4.173 (t, 2H, J=6), 6.950 (d, 2H, J=9), 7.16-7.30 (m, 5H), 8.189 (d, 1H, J=9).

30

## Example 65

## 4-Benzyl-1-[2-(4-aminophenoxy)ethyl]piperidine



35 This compound was prepared in a manner similar to example 61 as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.42-1.69 (m, 5H), 2.11-2.18 (m, 2H), 2.552 (d, 2H,

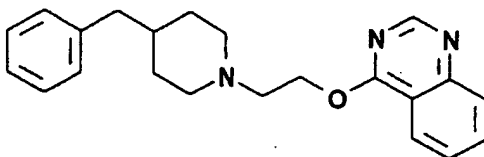
- 114 -

J=6.5), 2.829 (t, 2H, J=5.5), 3.05-3.09 (m, 2H), 3.380 (bs, 2H), 4.087 (t, 2H, J=5.5), 6.628 (d, 2H, J=9), 6.737 (d, 2H, J=9), 7.13-7.30 (m, 5H).

5

## Example 66

4-[2-(4-Benzylpiperidinoethoxy)quinazoline



10

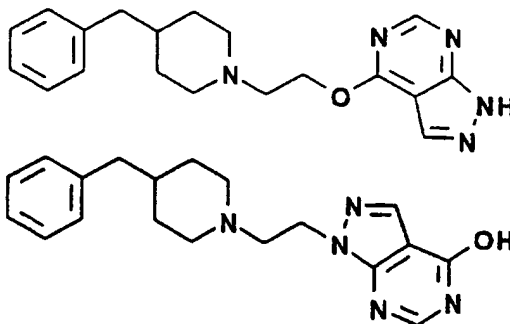
This compound was prepared in a manner similar to example 50. From 4-hydroxyquinazoline (169 mg, 1.16 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (232 mg, 0.98 mmol) there was obtained 243 mg (71.7%) of the amine as a bulk solid, mp 76-77°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.22-1.32 (m, 2H), 1.47-1.55 (m, 1H), 1.58-1.63 (m, 2H), 1.99-2.07 (m, 2H), 2.516 (d, 2H, J=7), 2.661 (t, 2H, J=6), 2.83-2.87 (m, 2H), 4.075 (t, 2H, J=6), 7.11-7.29 (m, 4H), 7.47-7.52 (m, 2H), 7.07-7.85 (m, 2H), 8.087 (s, 1H), 8.310 (d, 1H, J=8). Anal. Calcd. for C<sub>21</sub>H<sub>25</sub>N<sub>3</sub>O: C 75.19, H 7.51, N 12.53; Found: C 75.46, H 7.07, N 11.75.

25

## Example 67

4-[2-(4-Benzylpiperidino)ethoxy]pyrazolo-[3,4-d]pyrimidine (A) and 1-[2-(4-Benzylpiperidino)ethyl]-4-hydroxypyrazolo[3,4-d]pyrimidine (B)

30





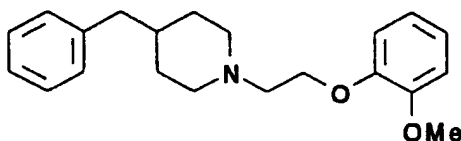
- 115 -

Similar treatment of 4-hydroxypyrazolo[3,4-d]-pyrimidine (204 mg, 1.50 mmol) with NaOH (70 mg, 1.75 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (357 mg, 1.50 mmol) gave 135 mg (25%) of white powder, mp 178-193°C. It was TLC (EtOAc-EtOH, 10 : 1) pure, but <sup>1</sup>H NMR indicated that it was a mixture of the title compounds.

## Example 68

10

4-Benzyl-1-[2-(2-methoxyphenoxy)ethyl]piperidine

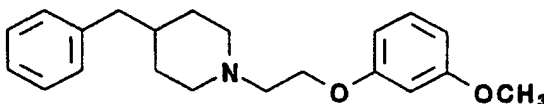


15 From 1-(2-Bromoethoxy)-2-methoxybenzene (515 mg, 2.23 mmol) and 4-benzylpiperidine (785 mg, 4.48 mmol) there was obtained 560 mg (85%) of the amine as a yellowish oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.27-1.40 (m, 2H), 1.47-1.58 (m, 1H), 1.62-1.66 (m, 2H), 1.99-2.06 (m, 2H), 2.543 (d, 2H, J=7), 2.745 (t, 2H, J=6), 2.95-2.99 (m, 2H), 3.760 (s, 3H), 4.041 (t, 2H, J=6), 6.79-6.85 (m, 4H), 7.13-7.30 (m, 5H). The hydrochloride, mp 165-6°C.

25

## Example 69

4-Benzyl-1-[2-(3-methoxyphenoxy)ethyl]-piperidine



30

From the 1-(2-bromoethoxy)-3-methoxybenzene (1.732g, 7.48 mmol) and 4-benzylpiperidine (1.310 g, 7.48 mmol) there was obtained 750 mg (31%) of the amine as a colorless oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.27-1.40 (m, 2H), 1.48-1.59 (m, 1H), 1.62-1.66 (m, 2H), 2.00-2.08 (m, 2H), 2.540 (d, 2H, J=7), 2.771 (t, 2H, J=6), 2.95-2.99 (m, 2H), 3.784 (s, 3H), 4.081 (t, 2H, J=6), 6.47-6.48 (m,

- 116 -

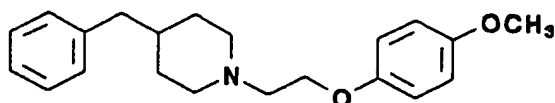
2H), 6.51 (bs, 1H), 7.13-7.30 (m, H). The hydrochloride, mp 122-3°C. Anal. Calcd. for (C<sub>21</sub>H<sub>27</sub>NO<sub>2</sub> + HCl): C, 69.69, H 7.80, N 3.87; Found: C 69.62, H 7.75, N 3.86.

5

## Example 70

## 4-Benzyl-1-[2-(4-methoxyphenoxy)ethyl]piperidine

10



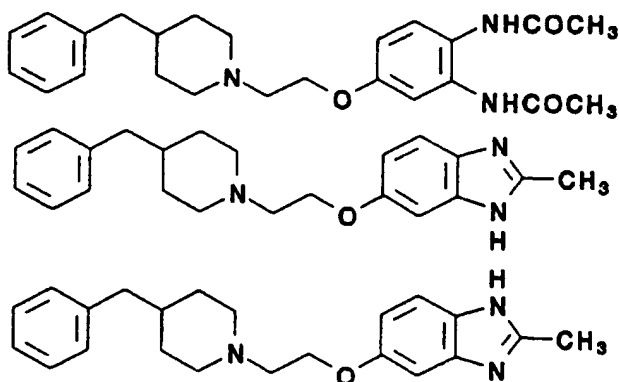
From 1-(2-bromoethoxy)-4-methoxybenzene (0.53 g, 2.3 mmol) and 4-benzylpiperidine (0.85 g, 4.86 mmol) there was obtained 600 mg (80%) of the amine as a yellowish oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.27-1.40 (m, 2H), 1.47-1.59 (m, 1H), 1.62-1.66 (m, 2H), 1.98-2.09 (m, 2H), 2.534 (d, 2H, J=7), 2.819 (t, 2H, J=6), 2.96-2.99 (m, 2H), 3.848 (s, 3H), 4.140 (t, 2H, J=6), 6.86-6.92 (m, 4H), 7.13-7.30 (m, 5H). The hydrochloride, mp 150-1°C.

20

## Example 71

4-Benzyl-1-[2-(3,4-bisacetamidophenoxy)ethyl]-piperidine, (A) 4-Benzyl-1-[2-(2-methylbenzimidazol-6-oxy)ethyl]piperidine (B) and 4-Benzyl-1-[2-(2-methylbenzimidazol-5-oxy)ethyl]piperidine (C)

25



30

To a solution of 4-benzyl-1-[2-(3,4-diaminophenoxy)ethyl] piperidine (260 mg, 0.8 mmol) in toluene (10 mL) was added acetyl chloride (3 mL). The

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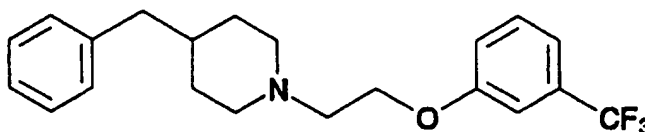
resulting mixture was refluxed under N<sub>2</sub> for 24 h, then cooled to r.t and evaporated. To the residue was added H<sub>2</sub>O (20 mL) and CHCl<sub>3</sub>. The mixture was cooled (ice-water), and 4 N aq. NaOH was added dropwise with stirring to adjust the pH to 10-11. The CHCl<sub>3</sub> layer was separated, and the aqueous was extracted with CHCl<sub>3</sub> (2 x 15 mL). The CHCl<sub>3</sub> solutions were combined, washed with brine (20 mL), and evaporated. The residue was chromatographed over silica gel (CHCl<sub>3</sub> : MeOH = 7 : 3) to first give 60 mg (17%) of the diacetimide as a colorless oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.27-1.40 (m, 2H), 1.49-1.67 (m, 3H), 2.03-2.07 (m, 2H), 2.272 (s, 3H), 2.289 (s, 3H), 2.543 (d, 2H, J = 7), 2.789 (t, 2H, J = 6), 2.95-2.99 (m, 2H), 4.115 (t, 2H, J = 6), 6.828 (d, 1H, J = 3), 7.020 (dd, 1H, J = 9, 3), 7.13-7.30 (m, 6H). The benzimidizoles was then obtained (70 mg, 25) as a yellowish oil, which showed one spot on TLC (CHCl<sub>3</sub>-MeOH, 7 : 3), and <sup>1</sup>H NMR (CDCl<sub>3</sub>) indicated that it was a mixture: 1.32-1.40 (m, 2H), 1.45-1.57 (m, 1H), 1.62-1.66 (m, 2H), 2.02-2.09 (m, 2H), 2.129 (s, 3H), 2.537 (t, 2H, J=7), 2.757 (t, 2H, J=6), 2.94-2.98 (m, 2H), 4.050 (t, 2H, J=6), 6.705 (dd, 2H, J=9; 2), 6.991 (d, 1H, J=2), 7.13-7.30 (m, 5H), 7.986 (bs, 0.5H, NH), 8.342 (bs, 0.5H, NH).

25

## Example 72

4-Benzyl-1-[2-(3-trifluoromethylphenoxy)-ethyl]piperidine

30



The compound was prepared in a manner similar to example 50. From 3-trifluoromethylphenol (1.626 g, 10.0 mmol) and 4-benzyl-1-(2-chloroethyl)piperidine (592 mg, 2.49 mmol) there was obtained 450 mg (50%) of

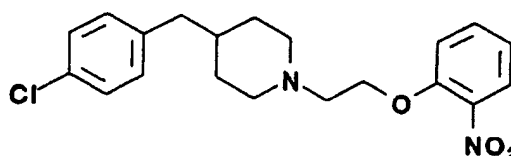
35

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the amine as an oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.38-1.43 (m, 2H), 1.50-1.60 (m, 1H), 1.64-1.68 (m 2H), 2.05-2.13 (m, 2H), 2.535 (d, 2H,  $J=7$ ), 2.812 (t, 2H,  $J=5.5$ ), 3.00-3.04 (m, 2H), 4.120 (t, 2H,  $J=5.5$ ), 6.94-7.37 (m, 9H). The 5 hydrochloride, mp 155-6 °C.

## Example 73

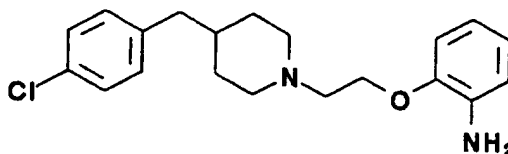
10 4-(4-Chlorobenzyl)-1-[2-(2-nitrophenoxy)-ethyl]piperidine



From 2-(2-nitrophenoxy)ethyl bromide (990 mg, 4.0 mmol) and 4-(4-chlorobenzyl)piperidine (840 mg, 4.0 mmol) there was obtained 190 mg (50%) of the amine as a yellow oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.28-1.40 (m, 2H), 1.48-1.55 (m, 1H), 1.62-1.67 (m, 2H), 2.11-2.18 (m, 2H), 2.507 (d, 2H,  $J=7$ ), 2.876 (t, 2H,  $J=6$ ), 3.00-3.04 (m, 2H), 4.263 (t, 2H,  $J=6$ ), 7.00-7.09 (m, 3H), 7.241 (d, 2H,  $J=8$ ), 7.49-7.55 (m, 2H), 7.81-7.84 (m, 1H).

## Example 74

25 4-(4-Chlorobenzyl)-1-[2-(2-aminophenoxy)ethyl]piperidine



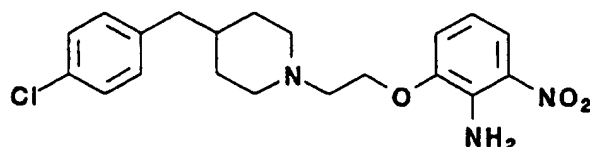
30 The nitro compound (100 mg, 0.27 mmol) was hydrogenated (Raney Ni /  $\text{H}_2$ ) to give 83 mg (90%) of the amine as a gray viscous oil. The hydrochloride was obtained as a highly hygroscopic solid.  $^1\text{H}$  NMR ( $\text{D}_2\text{O}$ ): 1.45-1.57 (m, 2H), 1.85-1.91 (m, 3H), 2.578 (d, 2H,  $J=7$ ), 2.97-3.05 (m, 2H), 3.58-3.68 (m, 4H), 4.479 (t, 2H,  $J=5$ ), 7.09-7.20 (m, 5H), 7.31-7.47 (m, 3H).

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## Example 75

4-(4-Chlorobenzyl)-1-[2-(2-amino-3-nitrophenoxy)ethyl]piperidine

5

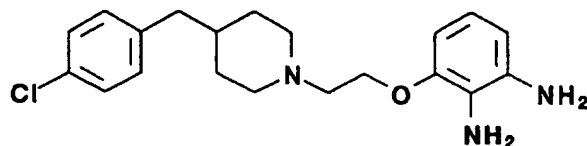


From 4-(4-chlorobenzyl)piperidine (1.22 g, 5.8 mmol) and 2-(2-amino-3-nitrophenoxy)ethyl bromide (740 mg, 3.0 mmol) there was obtained 696 mg (60%) of the amine as a solid, mp 85-6 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.23-1.36 (m, 2H), 1.47-1.58 (m, 1H), 1.63-1.66 (m, 2H), 2.02-2.09 (m, 2H), 2.522 (d, 2H, J=7), 2.772 (t, 2H, J=5.5), 2.95-2.98 (m, 2H), 4.112 (t, 2H, J=5.5), 6.573 (t, 1H, J=7.5), 6.740 (bs, 2H, NH<sub>2</sub>), 6.947 (d, 1H, J=7.5), 7.077 (d, 2H, J=8), 7.252 (d, 2H, J=8), 7.772 (d, 1H, J=7.5).

## Example 76

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4-(4-Chlorobenzyl)-1-[2-(2,3-diaminophenoxy)ethyl]piperidine



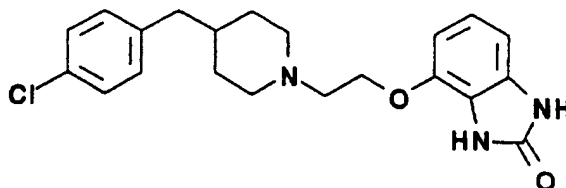
The nitro (636 mg, 1.63 mmol) was hydrogenated (Raney Ni/H<sub>2</sub>) to give 617 mg (95%) of the diamine as a deep purple bulk solid. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.23-1.36 (m, 2H), 1.45-1.55 (m, 1H), 1.60-1.64 (m, 2H), 2.00-2.08 (m, 2H), 2.503 (d, 2H, J=7), 2.767 (t, 2H, J=6), 2.95-2.99 (m, 2H), 3.415 (bs, 2H, NH<sub>2</sub>), 3.541 (bs, 2H, NH<sub>2</sub>), 4.102 (t, 2H, J=6), 6.402 (d, 1H, J=8), 6.408 (d, 1H, J=8), 6.636 (t, 1H, J=8), 7.065 (d, 2H, J=8.5), 7.242 (d, 2H, J=8.5).

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## Example 77

4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-4-oxy)ethyl]piperidine

5



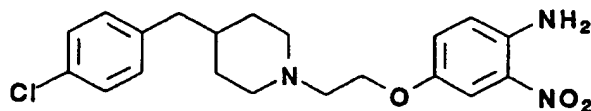
The compound was prepared in a manner similar to example 55. From the diamine (610 mg, 1.7 mmol) and CDI (405 mg, 2.5 mmol) there was obtained 380 mg (58%) of the title compound as a cream-colored powder, mp 147-8 °C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.15-1.24 (m, 2H), 1.41-1.52 (m, 3H), 1.92-1.99 (m, 2H), 2.488 (d, 2H, J=7), 2.653 (t, 2H, J=5.5), 2.88-2.92 (m, 2H), 4.105 (t, 2H, J=5.5), 6.561 (d, 1H, J=8), 6.615 (d, 1H, J=8), 6.836 (t, 1H, J=8), 7.182 (d, 2H, J=8), 7.320 (d, 2H, J=8), 10.544 (s, 1H), 10.689 (s, 1H). The hydrochloride, mp 175-5°C.

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## Example 78

4-(4-Chlorobenzyl)-1-[2-(4-amino-3-nitrophenoxy)ethyl]piperidine

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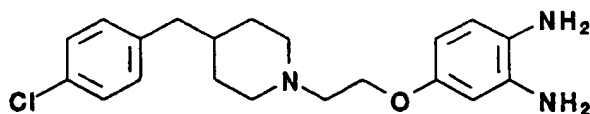
From 4-(4-chlorobenzyl)piperidine (1.25 g, 5.95 mmol) and 2-(4-amino-3-nitrophenoxy)ethyl bromide (738 mg, 3.0 mmol) there was obtained 826 mg (70%) of the amine as a yellow solid, mp 93-4 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.26-1.39 (m, 2H), 1.44-1.65 (m, 3H), 2.00-2.07 (m, 2H), 2.512 (d, 2H, J=7), 2.761 (t, 2H, J=6), 2.95-2.99 (m, 2H), 4.059 (t, 2H, J=6), 5.872 (bs, 2H, NH<sub>2</sub>), 6.746 (d, 1H, J=9), 7.06-7.08 (m, 3H), 7.23-7.27 (m, 2H), 7.568 (d, 1H, J=2.5).

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## Example 79

4-(4-Chlorobenzyl)-1-[2-(3,4-diaminophenoxy)ethyl]piperidine

5

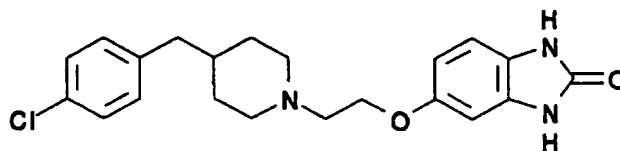


The nitro (690 mg, 1.77 mmol) was hydrogenated (Raney Ni/H<sub>2</sub>) to give 600 mg (94%) of the diamine as a brown viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.26-1.37 (m, 2H), 1.45-1.55 (m, 1H), 1.59-1.63 (m, 2H), 1.98-2.06 (m, 2H), 2.501 (d, 2H, J=7), 2.728 (t, 2H, J=6), 2.94-2.98 (m, 2H), 3.069 (bs, 2H, NH<sub>2</sub>), 3.503 (bs, 2H, NH<sub>2</sub>), 4.005 (t, 2H, J=6), 6.250 (dd, 1H, J=8; 2), 6.321 (d, 1H, J=2), 6.618 (d, 1H, J=8), 7.066 (d, 2H, J=8), 7.240 (d, 2H, J=8).

## Example 80

4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine

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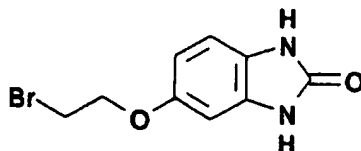
The compound was prepared in a manner similar to example 55. From the diamine (570 mg, 1.59 mmol) and CDI (324 mg, 2.0 mmol) there was obtained 365 mg (60%) of the title compound as an off-white powder, mp 211-2 °C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.14-1.22 (m, 2H), 1.40-1.52 (m, 3H), 1.89-1.97 (m, 2H), 2.487 (d, 2H, J=7), 2.590 (t, 2H, J=6), 2.86-2.89 (m, 2H), 3.965 (t, 2H, J=5.5), 6.561 (d, 1H, J=8), 6.48-6.51 (m 2H), 6.776 (d, 1H, J=8), 7.182 (d, 2H, J=8), 7.318 (d, 2H, J=8), 10.358 (s, 1H), 10.488 (s, 1H). The hydrochloride, mp. 277-9 °C.

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## Example 81

## 2-(2-Oxobenzimidazol-5-oxy)ethyl bromide

5



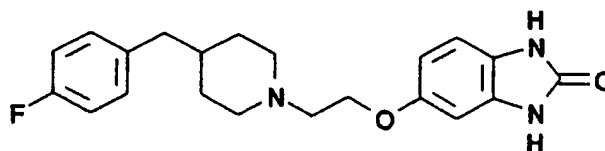
A solution of 2-(4-amino-3-nitrophenoxy)ethyl bromide (980 mg, 7.59 mmol) in dry THF (20 mL) was shaken over 5% Pd/C (80 mg) under H<sub>2</sub> (20-30 psi) for 5 h, then  
10 filtered. To the filtrate was added CDI (2.4 g, 14.8 mmol). The mixture was stirred at room temperature under N<sub>2</sub> for 4 h, then refluxed for 14 h. The mixture was evaporated, then the residual solid was washed with CHCl<sub>3</sub> (3 x 15 mL), and dried to give 407 mg (21%) of the  
15 title compound as an off-white powder, mp 225-6°C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 3.747 (t, 2H, J=5.5), 4.234 (t, 2H, J=5.5), 6.52-6.54 (m, 2H), 6.792 (d, 1H, J=9), 10.399 (s, 1H), 10.521 (s, 1H).

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## Example 82

## 4-(4-fluorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine

25



A mixture 2-(2-oxobenzimidazol-5-oxy)ethyl bromide (125 mg, 0.5 mmol), 4-(4-fluorobenzyl)piperidine (200 mg, 1.0 mmol) and NaI (50 mg) in THF (15 mL) was refluxed  
30 for 16 h, then cooled to room temperature. The mixture was filtered and the filter cake was washed with THF (2 x 5 mL). The filtrate and the washings were combined and evaporated. The residual solid was washed with EtOAc (2 x 10 mL) and CHCl<sub>3</sub> (2 x 5 mL), then dried to  
35 give 120 mg of crude product as an off-white powder.



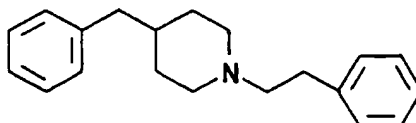
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The  $^1\text{H}$  NMR indicated that the desired product was contaminated by the starting material and the salt of the piperidine.

5

## Example 83

4-Benzyl-1-(2-phenylethyl)piperidine hydrochloride



10

From (2-bromoethyl)benzene (380 mg, 2.05 mmol) and 4-benzylpiperidine (724 mg, 4.13 mmol) there was obtained 400 mg (70%) of the amine as a yellow viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.31-1.41 (m, 2H), 1.43-1.60 (m, 1H), 1.66-

15

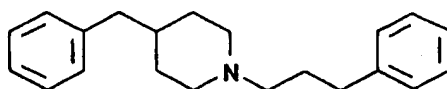
1.69 (m, 3H), 1.91-1.99 (m, 2H), 2.53-2.58 (m, 3H), 2.77-2.83 (m, 2H), 2.982 (m, 2H), 7.14-7.30 (m, 10H).

The hydrochloride, mp 251-252°C. Anal. Calcd. for  $\text{C}_{20}\text{H}_{26}\text{ClN}$ : C 76.05, H 8.30, N 4.43; Found: C 75.95, H 8.48, N 4.39.

20

## Example 84

4-Benzyl-1-(3-phenylpropyl)piperidine hydrochloride



25

From 1-bromo-3-phenylpropane (402 mg, 2.02 mmol) and 4-benzylpiperidine (715 mg, 4.08 mmol) there was obtained 500 mg (84%) of the amine as a yellow viscous oil,  $^1\text{H}$

30

NMR ( $\text{CDCl}_3$ ): 1.26-1.37 (m, 2H), 1.41-1.56 (m, 1H), 1.60-1.66 (m, 2H), 1.76-1.87 (m, 4H), 2.326 (t, 2H,  $J=8$ ), 2.525 (d, 2H,  $J=7$ ), 2.608 (t, 2H,  $J=8$ ), 2.87-2.91 (m, 2H), 7.12-7.29 (m, 10H). The hydrochloride, mp 191-

193°C. Anal. Calcd. for  $\text{C}_{21}\text{H}_{28}\text{ClN}$ : C 76.45, H 8.55, N

35

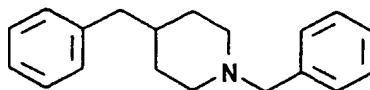
4.25; Found: 76.41, H 8.69, N 4.08.

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## Example 85

## 1,4-Dibenzylpiperidine

5



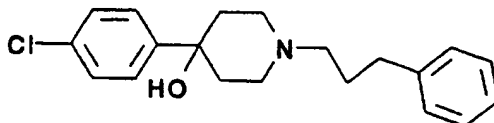
From benzyl bromide (351 mg, 3.1 mmol) and 4-benzylpiperidine (1.103 g, 6.3 mmol) there was obtained 540 mg (65%) of the amine as a yellowish powder, mp 60-10 61°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.22-1.37 (m, 2H), 1.43-1.56 (m, 1H), 1.58-1.64 (m, 2H), 1.85-1.93 (m, 2H), 2.526 (t, 2H, J=6.6), 2.84-2.87 (m, 2H), 3.470 (s, 2H), 7.12-7.30 (m, 10H). Anal. Calcd. for C<sub>19</sub>H<sub>27</sub>N: C 85.99, H 8.73, N 5.28; Found: 85.95, H 8.83, N 5.24.

15

## Example 86

## 4-(4-Chlorophenyl)-4-hydroxyl-1-(3-phenylpropyl)piperidine

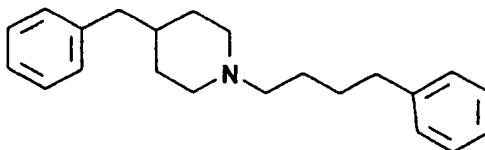
20



From 3-phenylpropyl bromide (200 mg, 1.0 mmol) and 4-(4-chlorophenyl)-4-hydroxypiperidine (212 mg, 1.0 mmol) there was obtained 100 mg (30%) of the amine as a yellowish powder, mp 107-8°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.52-1.75(m, 5H), 1.84-1.96 (m, 2H), 2.12-2.19 (m, 2H), 2.40-2.49 (m, 2H), 2.661 (t, 2H, J=7.6), 2.83-2.86 (m, 2H), 7.19-7.33 (m, 6H), 7.43-7.46 (m, 3H). Anal. 25 30 Calcd. for C<sub>20</sub>H<sub>24</sub>ClNO: C 72.82, H 7.33, N 4.25; Found: C 72.54, H 7.18, N 4.23.

## Example 87

## 35 4-Benzyl-1-(4-phenylbutyl)piperidine hydrochloride



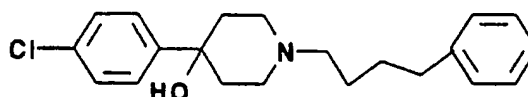
- 125 -

From 1-chloro-4-phenylbutane (338 mg, 2.0 mmol) and 4-benzylpiperidine (708 mg, 4.0 mmol) there was obtained 420 mg (68%) of the amine as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.22-1.37 (m, 2H), 1.52-1.70 (m, 7H), 1.79-1.87 (m, 2H), 2.28-2.33 (m, 2H), 2.525 (d, 2H, J=7), 2.59-2.64 (m, 2H), 2.87-2.90 (m, 2H), 7.12-7.20 (m, 6H), 7.25-7.30 (m, 4H). The hydrochloride, mp 167-8°C.

## Example 88

10

4-(4-Chlorophenyl)-4-hydroxyl-1-(4-phenylbutyl)piperidine



15

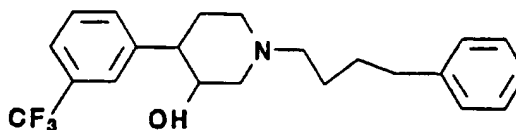
From 1-chloro-4-phenylbutane (203 mg, 1.2 mmol) and 4-(4-chlorophenyl)-4-hydroxypiperidine (514 mg, 2.4 mmol) there was obtained 30 mg (7%) of the amine as a yellowish powder, mp 110-111°C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.56-1.74 (m, 7H), 2.08-2.18 (m, 2H), 2.36-2.46 (m, 4H), 2.62-2.67 (m, 2H), 2.80-2.84 (m, 2H), 7.187 (d, 2H, J=7), 7.26-7.33 (m, 5H), 7.445 (d, 2H, J=7). Anal. Calcd. for C<sub>21</sub>H<sub>26</sub>ClNO: C 73.35, H 7.62, N 4.07; Found: C 73.59, H 7.54, N 4.12.

25

## Example 89

3-Hydroxy-1-(4-phenylbutyl)-4-(3-trifluoromethylphenyl)piperidine hydrochloride

30



From 1-chloro-4-phenylbutane (80 mg, 0.47 mmol) and 4-(3-trifluoromethylphenyl)-3-piperidinol (100 mg, 0.41 mmol) there was obtained 36 mg (20%) of the amine as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.46-1.75 (m, 7H), 2.12-2.22 (m, 2H), 2.37-2.46 (m, 4H), 2.650 (t, 2H, J=7), 2.82-2.86 (m, 2H), 7.18-7.31 (m, 4H), 7.43-7.53

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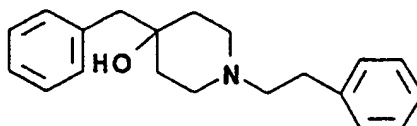
(m, 3H), 7.691 (d, 1H, J=7.5), 7.81 (bs, 1H). The hydrochloride, mp 177-8°C. Anal. Calcd. for  $C_{22}H_{27}ClF_3NO$ : C 63.84, H 6.58, N 3.38; Found: C 64.13, H 6.60, N 3.42.

5

## Example 90

## 4-Benzyl-4-hydroxy-1-(2-phenylethyl)piperidine hydrochloride

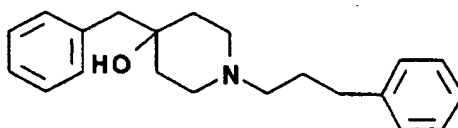
10



From 2-phenylethyl bromide (702 mg, 3.8 mmol) and 4-benzyl-4-hydroxypiperidine (1.51g, 7.9 mmol) there was  
 15 obtained 960 mg (83.6%) of the amine as a yellow viscous oil.  $^1H$  NMR ( $CDCl_3$ ): 1.20-1.27 (m, 1H), 1.54-1.60 (m, 4H), 1.75-1.85 (m, 2H), 2.35-2.42 (m, 2H), 2.60-2.65 (m, 2H), 2.78-2.85 (m, 4H), 7.19-7.34 (m, 10H). The hydrochloride, mp 233-5°C. Anal. Calcd. for  
 20  $C_{20}H_{26}ClNO$ : C 72.38, H 7.90, N 4.22; Found: C 72.06, H 7.90, N 3.97.

## Example 91

## 25 4-Benzyl-4-hydroxy-1-(3-phenylpropyl)piperidine hydrochloride



30 From 1-bromo-3-phenylpropane (598 mg, 3.0 mmol) and 4-benzyl-4-hydroxypiperidine (1.15 g, 6.0 mmol) there was obtained 780 mg (84%) of the amine as a yellow viscous oil.  $^1H$  NMR ( $CDCl_3$ ): 1.183 (s, 1H, OH), 1.50-1.54 (m, 2H), 1.71-1.89 (m, 4H), 2.24-2.32 (m, 2H), 2.397 (t, 35 2H, J=8), 2.60-2.70 (m, 4H), 2.755 (s, 2H), 7.12-7.34 (m, 10H). The hydrochloride, mp 156-7°C. Anal.

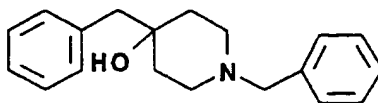
- 127 -

Calcd. for  $C_{21}H_{23}ClNO$ : C 72.92, H 7.87, N 4.05; Found: C 73.07, H 8.10, N 4.13.

## Example 92

5

## 1,4-Dibenzyl-4-hydroxypiperidine hydrochloride

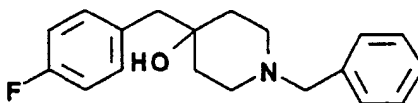


10 From benzyl bromide (334 mg, 1.95 mmol) and 4-benzyl-4-hydroxypiperidine (398 g, 2.0 mmol) there was obtained 150 mg (52%) of the amine as a yellow viscous oil. The hydrochloride, mp 200-1°C.  $^1H$  NMR ( $D_2O$ ): 1.72-1.92 (m, 4H), 2.803 (s, 2H), 3.13-3.35 (m, 4H), 4.268 (s, 2H),  
15 7.22-7.49 (m, 10H). Anal. Calcd. for  $C_{19}H_{24}ClNO$ : C 71.80, H 7.61, N 4.41; Found: C 71.94, H 7.72, N 4.25.

## Example 93

20

## 1-Benzyl-4-(4-fluorobenzyl)-4-hydroxypiperidine hydrochloride



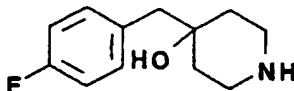
25 To a 250-ml three-necked round-bottomed flask was added 2.31 g of Mg turnings and 15 mL of anhydrous THF under  $N_2$ . To which was added dropwise a solution of 1,2-dibromoethane (0.489 g, 2.65 mmol) in 5 mL of THF at rt. After addition, THF was removed and the residue  
30 was rinsed with THF (2X5 mL). To this residue was added dropwise a solution of 4-fluorobenzyl chloride (13.4 g, 92.6 mmol) in 50 mL of THF at 0 °C. After addition, the solution was allowed to stir at rt for 2 hrs. and another 50 mL of THF was added. After cooling  
35 down to -35 °C - -40 °C, a solution of 4-benzylpiperidone (5.0 g, 26.5 mmol) in 20 mL of THF was added dropwise. After the addition was complete, the reaction mixture was allowed to stir at rt for 3 hrs

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and stand overnight. To this reaction mixture was added 100 mL of saturated  $\text{NH}_4\text{Cl}$  aqueous solution at 0 °C and then extracted with dichloromethane (2X50 mL). The combined organic phase was evaporated in vacuo to give 5 an oil, which was redissolved into 200 mL of dichloromethane and washed with saturated  $\text{NH}_4\text{Cl}$  aqueous solution (2X30 mL) and brine (50 mL), and then dried over sodium sulfate. Evaporation of solvent followed by flash chromatography ( $\text{EtOAc}$   $R_f$  = 0.25), giving 6.7 g 10 (85%) of the product as a pale yellow oil.  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  1.463 (m, 2 H), 1.680 (m, 2 H), 2.174 (s, 1 H), 2.290 (m, 2 H), 2.620 (m, 2 H), 2.725 (s, 2 H), 3.510 (s, 2 H), 6.890 (m, 2 H), 7.138 (m, 2 H), 7.268 (m, 5 H). The hydrochloride, mp 225-6°C. Anal. Calcd. 15 for  $\text{C}_{19}\text{H}_{23}\text{ClFNO}$ : C 67.95, H 6.90, N 4.17; Found: C 67.74, H 6.81, N 4.07.

## Example 94

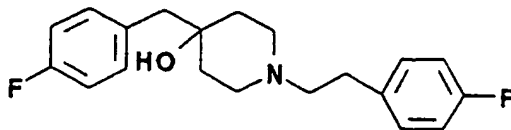
20 4-(4-Fluorobenzyl)-4-hydroxypiperidine



A mixture of 1-benzyl-4-(4-fluorobenzyl)-4-hydroxypiperidine (520 mg, 1.7 mmol), 5% Pd/C (150 mg) 25 and EtOH (15 mL) was shaken under  $\text{H}_2$  (30 psi) for 14 h and filtered. The filtrate was evaporated to give 350 mg (98%) of the title compound as a yellowish oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ), 1.45-1.64 (m, 6H), 2.792 (s, 2H), 2.63-2.96 30 (m, 4H), 6.97-7.02 (m, 2H), 7.14-7.19 (m, 2H).

## Example 95

35 4-(4-Fluorobenzyl)-1-[2-(4-fluorophenyl)ethyl]-4-hydroxypiperidine hydrochloride

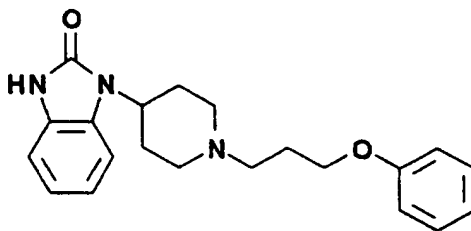


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A mixture of 2-(4-fluorophenyl)ethanol tosylate 432 mg, 1.47 mmol), 4-(4-fluorobenzyl)-4-hydroxypiperidine (200 g, 0.96 mmol),  $K_2CO_3$  (270 mg, 1.96 mmol) and EtOH (30 mL) was refluxed for 18 h, then worked up to give 146 mg (46%) of the title compound as a yellow viscous oil.  $^1H$  NMR ( $CDCl_3$ ): 1.51-1.56 (m, 2H), 1.73-1.83 (m, 2H), 2.35-2.43 (m, 2H), 2.58-2.63 (m, 3H), 2.74-2.82 (m, 6H), 6.92-7.02 (m, 4H), 7.12-7.19 (m, 4H). The hydrochloride, mp 197-8°C. Anal. Calcd. for  $C_{20}H_{24}ClF_2NO$ : C 65.30, H 6.58, N 3.81; Found: C 65.06, H 6.44, N 3.72.

## Example 96

15 4-(2-Keto-1-benzimidazoliny)-1-(3-phenoxypropyl)-piperidine hydrobromide



A mixture of 4-(2-keto-1-benzimidazoliny)piperidine 20 (980 mg, 4.51 mmol) and 3-phenoxypropyl bromide (1.02 g, 4.73 mmol) was reacted in the presence of  $K_2CO_3$  in  $CH_3CN$  by refluxing under  $N_2$  for about 4 h to obtain the hydrobromide as a pale beige solid (1.06 g, 54%); mp 136-138 °C (foams);  $^1H$  NMR ( $CD_3OD$ )  $\delta$  2.12 (d, J = 13 Hz, 2H), 2.25-2.40 (m, 2 H), 2.81-2.99 (m, 2 H), 3.22-3.49 (m, 4 H), 3.82 (d, J= 12 Hz, 2 H), 4.14 (t, J = 8.4 Hz, 2 H), 4.55-4.70 (m, 1 H), 6.91-7.41 (m, 9 H).

## Example 97

30

Preparation of 3-Hydroxy-1-(4-phenylbutyl)-4-(3-trifluoromethylphenyl)piperidine and the hydrochloride

35 From 1-chloro-4-phenylbutane (80 mg, 0.47 mmol), 4-(3-trifluoromethylphenyl)-3-piperidinol (100 mg, 0.41

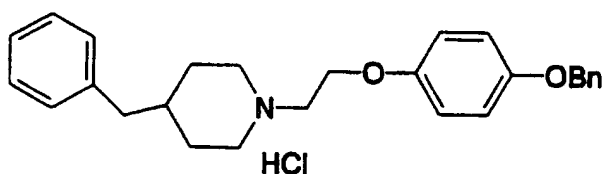
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mmol) and NaI (125 mg) in toluene (10 mL) was obtained 36 mg (20%) of the product as a yellow viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.46-1.75 (m, 7H), 2.12-2.22 (m, 2H), 2.37-2.46 (m, 4H), 2.650 (t, 2H, J=7), 2.82-2.86 (m, 2H), 5 7.18-7.31 (m, 4H), 7.43-7.53 (m, 3H), 7.691 (d, 1H, J=7.5), 7.81 (bs, 1H). The hydrochloride, mp 177-8°C. Analysis, Calcd. for C<sub>22</sub>H<sub>27</sub>ClF<sub>3</sub>NO: C 63.84, H 6.58, N 3.38; Found: C 64.13, H 6.60, N 3.42.

10

## Example 98

1-[2-(4-Benzyloxyphenoxy)ethyl]-4-benzylpiperidine hydrochloride



15

A) 2-(4-Benzyloxyphenoxy)ethyl bromide. A mixture of 4-(benzyloxy)phenol (10 g, 0.05 mol), potassium carbonate (17.3 g, 0.125 mol) in 50 mL of acetonitrile and 21.6 mL of 1,2-dibromoethane was allowed to reflux for 24 h. The inorganic salt was removed through a short column of silica gel and washed with ethyl acetate (3X25 mL). The combined filtrate was evaporated in vacuo to give a crude mixture, which was 25 purified by flash chromatography (5% EtOAc in hexane), giving 12 g (79%) of the bromide as a white solid. mp 75-77 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.611 (t, J = 6.2 Hz, 2 H), 4.242 (t, J = 6.2 Hz, 2 H), 5.021 (s, 2 H), 6.869 (m, 4 H), 7.381 (m, 5 H).

30

B) From a mixture of 2-(4-benzyloxyphenoxy)ethyl bromide (1.44 g, 4.7 mmol), 4-benzylpiperidine (0.876 g, 5.0 mmol), potassium carbonate (1.725 g, 12.5 mmol) in 50 mL of acetonitrile was obtained 1.62 g (86%) of the

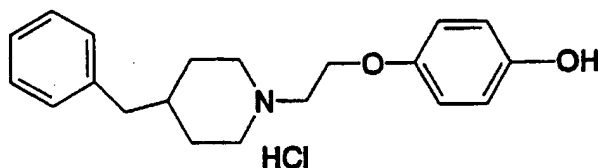


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free base. It was converted to its HCl salt in 100% yield. mp 164-166 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.509 (m, 1 H), 1.675 (d, J =12.3 Hz, 2 H), 2.460 (m, 4 H), 2.935 (m, 2 H), 3.349 (m, 2 H), 3.445 (d, J =11.7 Hz, 2 H), 4.257 (s, 2 H), 5.005 (s, 2 H), 6.892 (m, 4 H), 7.182-7.396 (m, 10 H), 10.2 (brs, 2 H).

## Example 99

## 10 1-[2-(4-hydroxyphenoxy)ethyl]-4-benzylpiperidine hydrochloride



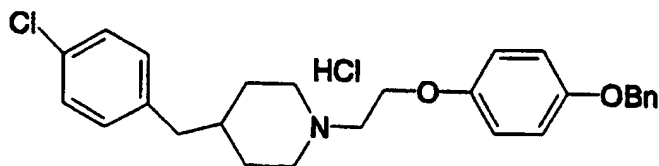
15 To a solution of 1-[2-(4-benzyloxyphenoxy)ethyl]-4-benzylpiperidine hydrochloride (401 mg, 1.0 mmol) in 25 mL of ethanol was added 1.0 mL of 1 M HCl in methanol and 100 mg of 10% Pd/C. The resulting mixture was hydrogenated at 30 psi of hydrogen for 2 h. The catalyst was removed through a short column of celite (5 g) and washed with methanol (3 x 15 mL). The combined filtrate was evaporated in vacuo to give an oil and then ether (30 mL) was added to the residue. The resulting mixture was allowed to stir at rt overnight. The white solid was collected by filtration and dried in vacuo, giving 330 mg (100%) of the title product. mp 212-215 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>+DMSO-d<sub>6</sub>) 1.656 (m, 3 H), 1.829 (m, 2 H), 2.425 (s, 2 H), 2.626 (m, 2 H), 3.187 (m, 2 H), 3.4 (brs, 1 H), 4.253 (s, 2 H), 6.549 (m, 4 H), 6.942-7.092 (m, 5 H), 12.0 (brs, 1 H).

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## Example 100

1 - [2 - (4 - Benzyloxyphenoxy) ethyl] - 4 -  
(chlorobenzyl) piperidine hydrochloride

5

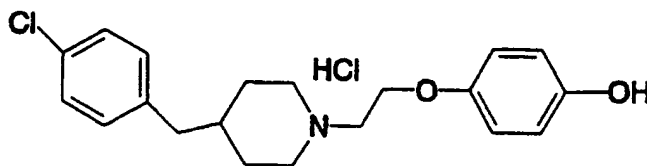


From a mixture of 2 - (4 - benzyloxyphenoxy) ethyl bromide  
(0.921 g, 3.0 mmol), 4 - chlorobenzyl piperidine  
10 hydrochloride (0.74 g, 3.0 mmol), potassium carbonate  
(1.035 g, 7.5 mmol) in 50 mL of acetonitrile there was  
obtained 1.1 g (85%) of the free base. It was converted  
to its HCl salt in 71% yield, mp 171-173 °C. <sup>1</sup>H NMR  
(DMSO-d<sub>6</sub>) 1.513 (m, 1 H), 1.656 (d, J = 12.6 Hz, 2 H),  
15 2.460 (m, 4 H), 2.972 (m, 2 H), 3.349 (m, 2 H), 3.438  
(d, J = 12 Hz, 2 H), 4.267 (s, 2 H), 5.004 (s, 2 H),  
6.900 (m, 4 H), 7.162-7.396 (m, 9 H), 10.2 (brs, 1 H).

## Example 101

20

1 - [2 - (4 - Hydroxyphenoxy) ethyl] - 4 -  
(chlorobenzyl) piperidine hydrochloride



25

To a solution of 1 - [2 - (4 - benzyloxyphenoxy) ethyl] - 4 - (4 -  
chlorobenzyl) piperidine (200 mg, 0.46 mmol) in 5 mL of  
chloroform was added 330 mg (1.65 mmol) of  
iodotrimethylsilane. The resulting solution was  
30 allowed to stir at rt for 30 min. and then methanol (4  
mL) was added and was stirred for 20 min. Evaporation  
of solvent gave a residue, which was purified by flash

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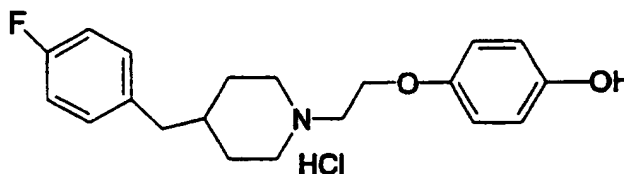
chromatography (20% methanol in chloroform) to give an oil. This oil was dissolved into 5 mL of methanol and 1 mL of 1 M HCl in methanol was added. The resulting solution was allowed to stir for 10 min. Evaporation of methanol gave a residue, to which was added ether (30 mL). The resulting mixture was allowed to stir at rt overnight. The white solid was collected by filtration and dried in vacuo, giving 91 mg (52%) of the title compound, mp 168-170 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.536 (m, 2 H), 1.656 (d, J = 12.6 Hz, 3 H), 2.615 (d, J = 6.9 Hz, 2 H), 3.060 (m, 2 H), 3.499 (m, 2 H), 3.591 (m, 2 H), 4.245 (t, J = 4.8 Hz, 2 H), 6.710 (m, 2 H), 6.823 (m, 2 H), 7.177 (d, J = 8.4 Hz, 2 H), 7.280 (d, J = 8.1 Hz, 2 H).

15

## Example 102

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-fluorobenzyl)piperidine hydrochloride

20



A) 4-Fluorobenzyltriphenylphosphonium bromide. To a solution of triphenylphosphine (26.2 g, 0.1 mol) in 100 mL of ether was added 4-fluorobenzyl bromide (18.9 g, 0.1 mol). The resulting solution was allowed to stir at rt overnight. The white solid was collected by filtration and dried to give 37.0 g (82%) of the bromide as a white solid. mp 280-282 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 5.492 (d, J = 14.4 Hz, 2 H), 6.773 (d, J = 8.7 Hz, 2 H), 7.123 (m, 2 H), 7.596 (m, 6 H), 7.749 (m, 9 H).

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B) 1-Benzyl-4-(4-fluorobenzylidene)piperidine. To a 250-mL three-necked round bottom flask was added 1.28 g (60% in mineral oil) of sodium hydride and 20 mL of dry DMSO under N<sub>2</sub>. The mixture is heated at 80 °C for 1 h. 5 The resulting solution was cooled in an ice-water bath. To this solution was added a suspension of 4-fluorobenzyltriphenylphosphonium bromide (16.23 g, 0.036 mol) in 120 mL of warm DMSO. The resulted solution was stirred at 0 °C for 10 min. and at rt for 10 15 min. Then 4-benzylpiperidone (5.67 g, 0.03 mol) was added dropwise under N<sub>2</sub>. The resulting mixture was allowed to stir at 80 °C overnight. Then the mixture was poured into ice (400 g) and extracted with ether (3 x 200 mL). The combined extracts was dried over sodium 15 sulfate. The solvent was evaporated in vacuo to give a residue, which was purified by flash chromatography (eluent 5 % EtOAc in hexanes), giving 7.0 g (83%) of the amine as a pale yellow oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.359-2.545 (m, 8 H), 3.530 (s, 2 H), 6.220 (s, 1 H), 6.983 20 (m, 2 H), 7.135 (m, 2 H), 7.262-7.335 (m, 5 H).

C) 1-Benzyl-4-(4-fluorobenzyl)piperidine hydrochloride. To a solution of 1-benzyl-4-(4-fluorobenzylidene)piperidine (4.22 g, 15 mmol) in 100 25 mL of methanol was added 200 mg of PtO<sub>2</sub>. The resulting mixture was hydrogenated at 40 psi for 8 h. The catalyst was removed through a short column of Celite (10 g) and was washed with methanol (3 x 20 mL). The filtrate was evaporated in vacuo and dissolved into 20 30 mL of methanol, to which was added 30 mL of 1 M HCl in methanol. The resulting solution was stirred for 10 min. Evaporation of methanol gave a residue, to which was added 60 mL of ether and stirred for overnight. An off white solid was collected by filtration and dried 35 to give 4.6 g (96%) of the salt, mp 168-170 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.626 (m, 2 H), 1.733 (m, 2 H), 2.089 (q, J = 12.3 Hz, 2 H), 2.564 (m, 3 H), 3.414 (d, J = 11.1 Hz, 2

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H), 4.104 (d, J = 5.1 Hz, 2 H), 6.944 (m, 2 H), 7.050 (m, 2 H), 7.431 (m, 3 H), 7.605 (m, 2 H), 12.41 (s, 1 H).

5 D) 4-(4-Fluorobenzyl)piperidine hydrochloride. A mixture of 1-benzyl-4-(4-fluorobenzyl)piperidine hydrochloride (4.5 g, 14 mmol) and 1.93 g of 10% Pd/C in 100 mL of 95% ethanol was hydrogenated to give 3.2 g (98%) of the title compound, mp 158-160 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.699-1.808 (m, 5 H), 2.570 (m, 2 H), 2.792 (m, 2 H), 3.450 (m, 2 H), 6.976 (m, 2 H), 7.048 (m, 2 H), 9.451 (brs, 2 H).

E) 1-[2-(4-Benzyloxyphenoxy)ethyl]-4-(4-fluorobenzyl)piperidine. From a mixture of 2-(4-benzyloxyphenoxy)ethyl bromide (3.50 g, 11.4 mmol), 4-fluorobenzylpiperidine hydrochloride (2.6 g, 11.4 mmol), potassium carbonate (3.91 g, 28 mmol) in 60 mL of acetonitrile was obtained 4.0 g (84%) of the amine as a pale yellow solid. mp 73-75 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.262 (m, 3 H), 1.621 (m, 2 H), 2.013 (m, 2 H), 2.470 (d, J = 6.9 Hz, 2 H), 2.730 (t, J = 6.0 Hz, 2 H), 2.933 (m, 2 H), 4.019 (t, J = 5.7 Hz, 2 H), 4.987 (s, 2 H), 6.784 - 6.961 (m, 7 H), 7.067 (m, 2 H), 7.290 - 7.412 (m, 4 H).

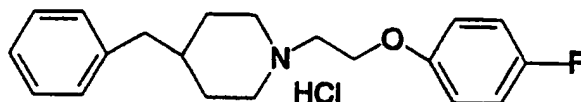
F) A mixture of 1-[2-(4-benzyloxyphenoxy)ethyl]-4-(4-fluorobenzyl)piperidine (4.0 mg, 9.5 mmol) in 100 mL of methanol and 1.0 g of 5% Pd/C was hydrogenated to give 3.2 g (95%) of the title compound, mp 196-198 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.58 (m, 2 H), 1.890 (m, 3 H), 2.602 (d, J = 6.3 Hz, 2 H), 3.08 (m, 2 H), 3.49 (t, J = 5.1 Hz, 2 H), 3.62 (m, 2 H), 4.250 (t, J = 5.1 Hz, 2 H), 6.771 (d, J = 9.3 Hz, 2 H), 7.017 (m, 2 H), 7.196 (m, 2 H). Anal. Calcd for C<sub>20</sub>H<sub>23</sub>ClFNO<sub>2</sub>·0.15H<sub>2</sub>O: C, 65.17; H, 6.92; N, 3.80. Found: C, 64.93; H, 6.80; N, 4.13.

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## Example 103

4-Benzyl-1-(2-(4-fluorophenoxy)ethyl)piperidine  
hydrochloride

5

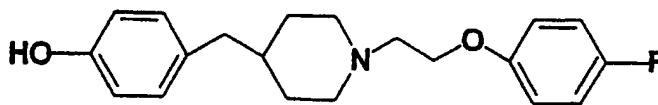


From a mixture of 4-benzylpiperidine (500 mg, 2.85 mmol), 2-(4-fluorophenoxy)ethyl bromide (655 mg, 2.99 mmol) and  $K_2CO_3$  (413 mg, 2.99 mmol) in  $CH_3CN$  (20 mL) was obtained the title compound as a fluffy, colorless, crystalline solid (395 g, 79%): mp 165-167 °C,  $^1H$  NMR ( $CDCl_3$ ) 1.70-1.90 (m, 3H), 1.94-2.14 (m, 2H), 2.59 (d,  $J$  = 7.2 Hz, 2H), 2.65-2.85 (m, 2H), 3.20-3.50 (m, 2H), 3.65 (d,  $J$  = 12 Hz, 2H), 4.49 (t,  $J$  = 4.5 Hz, 2H), 6.76-7.30 (m, 9H), 12.47 (bs, 1H); Anal. Calcd for  $C_{20}H_{23}ClFNO$ : C, 68.66; H, 7.20; N, 4.00. Found: C, 68.66; H, 7.11; N, 3.98.

20

## Example 104

1-(2-(4-Fluorophenoxy)ethyl)-1-(4-hydroxybenzyl)piperidine



25

From a solution of  $BBr_3$  in  $CH_2Cl_2$  (3 mL, 1 M) and 1-(2-(4-fluorophenoxy)ethyl)-1-(4-methoxybenzyl)piperidine hydrochloride (300 mg, 790  $\mu$ mol) in dry  $CH_2Cl_2$  (20 mL) was obtained a colorless granular solid (155 mg, 60%): mp 149-150 °C,  $^1H$  NMR ( $DMSO-d_6$ ) 1.12-1.20 (m, 2H), 1.28-1.44 (m, 1H), 1.48 (d,  $J$  = 12 Hz, 2H), 1.84-1.96 (m, 2H), 2.33 (d,  $J$  = 6.6 Hz, 2H), 2.59 (t,  $J$  = 6.0 Hz, 2H), 2.84 (d,  $J$  = 11 Hz, 2H), 3.98 (t,  $J$  = 6.0 Hz, 2H), 6.63 (d,  $J$  = 2.1 Hz, 2H), 6.86-6.96 (m, 4H), 7.02-7.12

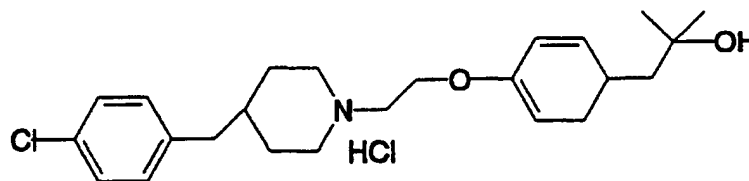
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(m, 2H), 9.12 (s, 1H); Anal. Calcd for  $C_{20}H_{24}FNO_2 \cdot 0.1 H_2O$ : C, 72.52; H, 7.36; N, 4.23. Found: C, 72.44; H, 7.11; N, 4.17.

5

## Example 105

3-{4-[2-(4-Chlorobenzyl)piperidino]ethoxy}phenyl}-2-methyl-2-propanol hydrochloride



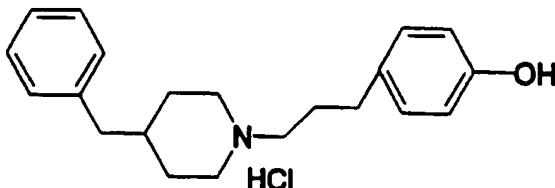
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To a solution of 1-[2-(4-ethoxycarbonylmethylphenoxy)ethyl]-4-(4-chlorobenzyl)piperidine (415.5 mg, 1.0 mmol) in 10 mL of anhydrous THF was added 2 mL of 1.4 M MeMgBr in toluene/THF at -78 °C. The resulting solution was allowed to warm to rt and stir at rt for another 3 h. Then the solution was poured into water (5 mL) and extracted with ethyl acetate (3 x 25 mL). The combined extracts were washed with brine (10 mL) and dried over sodium sulfate. Evaporation of solvent gave a residue, which was purified by flash chromatography (20% methanol in chloroform), giving 312 mg (78%) of free base. The hydrochloride, mp 55-56 °C.  $^1H$  NMR ( $CD_3OD$ ) 1.207 (s, 6 H), 1.70 (m, 2 H), 1.800 (m, 2 H), 2.056 (m, 2 H), 2.592 (d, J = 6.9 Hz, 2 H), 2.703 (s, 2 H), 2.769 (s, 2 H), 3.370 (brs, 2 H), 3.647 (m, 2 H), 4.531 (brs, 2 H), 6.802 (d, J = 8.4 Hz, 2 H), 7.04 (d, J = 8.4 Hz, 2 H), 7.121 (d, J = 8.4 Hz, 2 H), 7.261 (d, J = 8.4 Hz, 2 H), 12.65 (brs, 1 H).

## Example 106

1-[3-(4-Hydroxyphenyl)propyl]-4-benzylpiperidine  
hydrochloride

5



A) Ethyl 4-hydroxyphenylpropionate. From a solution of 4-hydroxyphenylpropionic acid (8.4 g, 50 mmol) in 10 200 mL of ethanol with 4 mL of concentrated sulfuric acid was obtained 9.7 g (100%) of the title compound as a pale oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.235 (t, J = 6.9 Hz, 3 H), 2.584 (t, J = 8.1 Hz, 2 H), 2.873 (t, J = 8.1 Hz, 2 H), 4.113 (q, J = 6.9 Hz, 2 H), 6.880 (d, J = 8.4 Hz, 2 H), 15 7.135 (d, J = 8.4 Hz, 2 H).

B) Ethyl 4-benzyloxyphenylpropionate. From a mixture of ethyl 4-hydroxyphenylpropionate (9.7g, 50 mmol), benzyl bromide (8.58 g, 50 mmol), potassium carbonate 20 (10.35 g, 75 mmol) in 100 mL of acetonitrile was obtained the title compound (85% yield) as a clear oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.232 (t, J = 7.2 Hz, 3 H), 2.582 (t, J = 8.1 Hz, 2 H), 2.892 (t, J = 8.1 Hz, 2 H), 4.110 (q, J = 7.2 Hz, 2 H), 5.040 (s, 2 H), 6.915 (d, J = 8.4 Hz, 2 25 H), 7.133 (d, J = 8.4 Hz, 2 H), 7.416 (m, 5 H).

C) 3-(4-Benzyloxyphenyl)propan-1-ol. To a slurry of lithium aluminium hydride (1.6 g, 42 mmol) in 50 mL of ether was added dropwise a solution of ethyl 4- 30 benzyloxyphenylpropionate (12 g, 42 mmol) in 100 mL of ether at 0 °C. After addition, the resulting mixture was allowed to stir at rt overnight. Then the reaction was quenched by the slow and dropwise addition of water (10 mL), followed by addition of 100 mL of 1 M HCl



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aqueous solution. The mixture was stirred for 15 min., then the organic layer was separated. The water phase was extracted again with ether (2 x 50 mL). The combined extracts were washed with brine (50 mL), dried over sodium sulfate. Evaporation of solvent gave 9.76 g (96%) of the title compound as a white solid. mp 60-62 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.863 (t, J = 6.6 Hz, 2 H), 2.628 (t, J = 7.5 Hz, 2 H), 3.669 (t, J = 6.3 Hz, 2 H), 5.042 (s, 2 H), 6.919 (d, J = 7.8 Hz, 2 H), 7.129 (d, J = 7.8 Hz, 2 H), 7.420 (m, 5 H).

D) 3-(4-Benzyloxyphenyl)prop-1-yl mesylate. To a solution of 3-(4-benzyloxyphenyl)propan-1-ol (9.76 g, 40 mmol) in 75 mL of methylene dichloride and 7.8 mL of triethylamine was added dropwise methanesulfonyl chloride (9.17 g, 80 mmol) at -20 °C. The resulting mixture was allowed to stir at rt for 30 min. and was diluted with 100 mL of methylene dichloride. The solution was washed with 1M HCl (2 x 100 mL), saturated sodium bicarbonate solution (100 mL) and brine (50 mL), then was dried over MgSO<sub>4</sub>. Evaporation of solvent gave 12.2 g (95 %) of the crude title compound as a white solid. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.042 (t, J = 6.6 Hz, 2 H), 2.694 (t, J = 7.5 Hz, 2 H), 2.984 (s, 3 H), 4.195 (t, J = 6.0 Hz, 2 H), 5.045 (s, 2 H), 6.928 (d, J = 8.4 Hz, 2 H), 7.116 (d, J = 8.4 Hz, 2 H), 7.418 (m, 5 H).

E) 1-[3-(4-Benzyloxyphenyl)propyl]-4-benzylpiperidine hydrochloride. From a mixture of 3-(4-benzyloxyphenyl)prop-1-yl mesylate (0.96 g, 3.0 mmol), 4-benzylpiperidine (0.526 g, 3.0 mmol), potassium carbonate (1.035 g, 7.5 mmol) in 20 mL of acetonitrile was obtained 0.7 g (54%) of the title compound, mp 203-205 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.65 (m, 1 H), 1.798 (d, J = 14.4 Hz, 2 H), 2.073 (m, 2 H), 2.214 (m, 2 H), 2.458 (m, 2 H), 2.635 (m, 4 H), 2.849 (m, 2 H), 3.516 (d, J = 10.8 Hz, 2 H), 5.028 (s, 2 H), 6.904 (d, J = 8.4 Hz, 2

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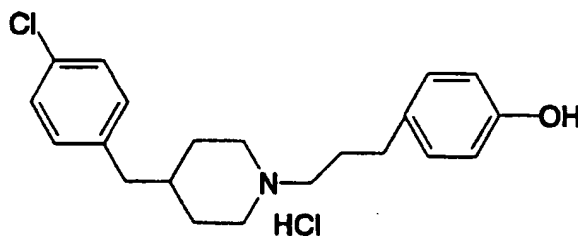
H), 7.120 (d, J = 8.4 Hz, 2 H), 7.225-7.406 (m, 5 H), 12.2 (s, 1 H).

F) A mixture of 1-[3-(4-benzoxypyphenyl)propyl]-4-  
5 benzylpiperidine (200 mg, 0.46 mmol) in 25 mL of  
ethanol with 50 mg of 10% Pd/C was hydrogenated at 30  
psi of hydrogen to give 135 mg (85%) of the title  
compound, mp 208-210 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.477 (m, 2  
H), 1.875 (m, 2 H), 1.964 (m, 2 H), 2.579 (m, 4 H),  
10 2.859 (m, 2 H), 3.010 (m 2 H), 3.282 (s, 2 H), 3.483  
(m, 2 H), 6.697 (d, J = 8.4 Hz, 2 H), 7.026 (d, J = 8.4  
Hz, 2 H), 7.138-7.255 (m, 5 H).

## Example 107

15

1-[3-(4-Hydroxyphenyl)propyl]-4-(4-  
chlorobenzyl)piperidine hydrochloride



20

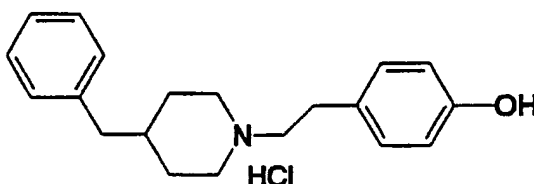
A) 1-[3-(4-Benzoyloxyphenyl)propyl]-4-(4-  
chlorobenzyl)piperidine hydrochloride. From a mixture  
of 3-(4-benzoyloxyphenyl)prop-1-yl mesylate (0.96 g, 3.0  
mmol), 4-chlorobenzylpiperidine hydrochloride (0.74 g,  
25 3.0 mmol), potassium carbonate (1.035 g, 7.5 mmol) in  
20 mL of acetonitrile was obtained 0.68 g (48%) of the  
title compound, mp 202-204 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.645 (m,  
1 H), 1.731 (m, 2 H), 2.086 (m, 2 H), 2.220 (m, 2 H),  
2.465 (m, 2 H), 2.577-2.668 (m, 4 H), 2.849 (m, 2 H),  
30 3.487 (d, J = 11.7 Hz, 2 H), 5.034 (s, 2 H), 6.881 (d,  
J = 8.7 Hz, 2 H), 7.030 (d, J = 8.7 Hz, 2 H), 7.058 (d,  
J = 10.2 Hz, 2 H), 7.238 (d, J = 10.2 Hz, 2 H), 7.384  
(m, 5 H), 12.25 (brs, 1 H).

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B) From a solution of 1-[3-(4-benzyloxyphenyl)propyl]-4-(4-chlorobenzyl)piperidine (100 mg, 0.212 mmol) in 5 mL of chloroform with 300 mg of iodotrimethylsilane was obtained 72 mg (90%) of the title compound, mp 183-185 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.416 (m, 2 H), 1.860 (m, 3 H), 1.983 (m, 2 H), 2.603 (m, 4 H), 2.882 (m, 2 H), 3.049 (m, 2 H), 3.505 (d, J = 12.3 Hz, 2 H), 6.694 (d, J = 8.4 Hz, 2 H), 7.019 (d, J = 8.4 Hz, 2 H), 7.157 (d, J = 8.1 Hz, 2 H), 7.264 (d, J = 8.1 Hz, 2 H).

## Example 108

15 1-[2-(4-Hydroxyphenyl)ethyl]-4-benzylpiperidine hydrochloride



A) 2-(4-Benzyloxyphenyl)ethyl mesylate was prepared from ethyl 4-hydroxyphenylacetate and benzyl bromide in three steps as a white solid, mp 48-50 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.828 (s, 3 H), 2.993 (t, J = 6.9 Hz, 2 H), 4.377 (t, J = 6.9 Hz, 2 H), 5.045 (s, 2 H), 6.921 (d, J = 8.4 Hz, 2 H), 7.136 (d, J = 8.4 Hz, 2 H), 7.396 (m, 5 H).

B) 1-[2-(4-Benzyloxyphenyl)ethyl]-4-benzylpiperidine hydrochloride. From a mixture of 2-(4-benzyloxyphenyl)ethyl mesylate (0.96 g, 3.5 mmol), 4-benzylpiperidine (0.526 g, 3.0 mmol), potassium carbonate (1.035 g, 7.5 mmol) in 20 mL of acetonitrile was obtained 0.5 g (40%) of the title compound, mp 183-185 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.72 (m, 1 H), 1.805 (d, J = 12.6 Hz, 2 H), 2.116 (m, 2 H), 2.573 (brs, 2 H), 2.626

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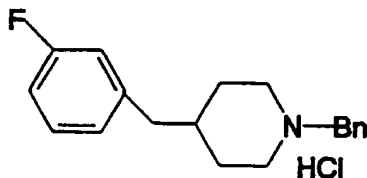
(d,  $J = 6.9$  Hz, 2 H), 3.085 (m, 2 H), 3.190 (m, 2 H), 3.574 (m, 2 H), 5.030 (s, 2 H), 6.895 (d,  $J = 8.4$  Hz, 2 H), 7.117 (m, 3 H), 7.214-7.402 (m, 9 H), 12.42 (brs, 1 H).

5

C) 1-[2-(4-Hydroxyphenyl)ethyl]-4-benzylpiperidine hydrochloride. A mixture of 1-[2-(4-benzyloxyphenyl)ethyl]-4-benzylpiperidine (200 mg, 0.46 mmol) in 25 mL of ethanol with 50 mg of 10% Pd/C was  
10 hydrogenated at 30 psi of hydrogen to give 155 mg (98%) of the title compound, mp 222-224 °C.  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ ) 1.487 (m, 2 H), 1.897 (m, 3 H), 2.626 (d,  $J = 6.6$  Hz, 2 H), 2.908-2.963 (m, 4 H), 3.207-3.261 (m, 2 H), 3.573 (m, 2 H), 6.731 (d,  $J = 8.4$  Hz, 2 H), 7.075 (d,  $J = 8.4$   
15 Hz, 2 H), 7.175 (m, 3 H), 7.310 (m, 2 H).

## Example 109

20 1-Benzyl-4-(3-fluorobenzyl)piperidine hydrochloride



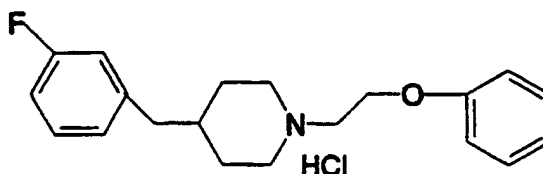
The title compound was prepared from triphenylphosphine and 3-fluorobenzyl bromide in three steps, mp 153-155  
25 °C.  $^1\text{H}$  NMR ( $\text{CHCl}_3$ ) 1.647 (m, 1 H), 1.775 (m, 2 H), 2.109 (s, 2 H), 2.597 (s, 4 H), 3.450 (s, 2 H), 4.128 (s, 2 H), 6.857 (m, 3 H), 7.260 (m, 1 H), 7.434 (s, 3 H), 7.592 (s, 2 H), 12.398 (brs, 1 H). Anal. Calcd for  $\text{C}_{19}\text{H}_{23}\text{ClFN}$ : C, 71.35; H, 7.25; N, 4.38. Found: C, 71.33; 30 H, 7.19; N, 4.60.

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## Example 110

1-(2-Phenoxyethyl)-4-(3-Fluorobenzyl)piperidine  
hydrochloride

5



A) 4-(3-Fluorobenzyl)piperidine hydrochloride. A solution of 1-benzyl-4-(3-fluorobenzyl)piperidine hydrochloride (319 mg, 1.0 mmol) in 10 ml of methanol with 80 mg of 10% Pd/C was hydrogenated at 50 psi to give 228 mg (98%) of the title compound, mp 173-175 °C. <sup>1</sup>H NMR (CHCl<sub>3</sub>) 1.613-1.807 (m, 5 H), 2.593 (m, 2 H), 2.785 (m, 2 H), 3.481 (m, 2 H), 6.880 (m, 3 H), 7.25 15 (m, 1 H), 9.363 (s, 1 H), 9.634 (s, 1 H).

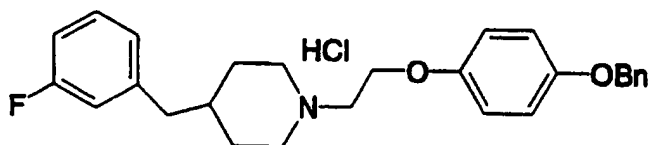
B) From a mixture of 4-(3-fluorobenzyl)piperidine hydrochloride (229.5 mg, 1.0 mmol), 2-phenoxyethyl tosylate (350.4 mg, 1.2 mmol), potassium carbonate (414 20 mg, 3.0 mmol) in 15 mL of ethanol was 175 mg (50%) of the title compound, mp 175-177 °C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) 1.696 (m, 1 H), 1.582 (m, 2 H), 2.096 (m, 2 H), 2.617 (m, 2 H), 2.781 (m, 2 H), 3.395 (m, 2 H), 3.687 (m, 2 H), 4.547 (s, 2 H), 6.756-6.999 (m, 6 H), 7.288 (m, 3 25 H), 12.556 (s, 1 H). Anal. Calcd for C<sub>20</sub>H<sub>23</sub>ClFNO: C, 68.66; H, 7.20; N, 4.00. Found: C, 68.37; H, 7.09; N, 3.98.

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## Example 111

1-[2-(4-Benzyloxyphenoxy)ethyl]-4-(3-fluorobenzyl)piperidine hydrochloride

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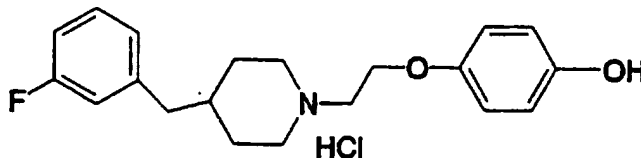
From a mixture of 2-(4-benzyloxyphenoxy)ethyl bromide (0.767 g, 2.5 mmol), 4-(3-fluorobenzyl)piperidine hydrochloride (0.459 g, 2.0 mmol), potassium carbonate (0.69 g, 5.0 mmol) in 20 mL of acetonitrile was obtained 600 mg (66%) of the title compound, mp 154-156 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.795 (m, 3 H), 2.056 (m, 2 H), 2.613 (d, J = 7.2 Hz, 2 H), 2.758 (m, 2 H), 3.354 (m, 2 H), 3.646 (d, J = 7.8 Hz, 2 H), 4.485 (s, 2 H), 5.006 (s, 2 H), 6.815 (m, 4 H), 6.877 (m, 4 H), 7.736 (m, 5 H), 12.6 (brs, 1 H). Anal. Calcd for C<sub>27</sub>H<sub>31</sub>ClFNO<sub>2</sub>·0.3H<sub>2</sub>O: C, 70.28; H, 6.90; N, 3.04. Found: C, 70.28; H, 6.70; N, 3.12.

20

## Example 112

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(3-fluorobenzyl)piperidine hydrochloride

25



A mixture of 1-[2-(4-benzyloxyphenoxy)ethyl]-4-(3-fluorobenzyl)piperidine hydrochloride (200 mg, 0.44 mmol) in 25 mL of ethanol with 60 mg of 20% Pd(OH)<sub>2</sub> was hydrogenated at 30 psi of hydrogen to give 153 mg (95%) of the title compound, mp 176-178 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD)

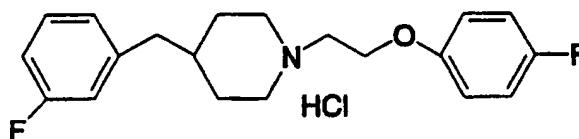
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1.558 (m, 2 H), 1.881 (m, 3 H), 2.640 (d,  $J = 6.9$  Hz, 2 H), 3.058 (m, 2 H), 3.506 (m, 2 H), 3.609 (d,  $J = 7.6$  Hz, 2 H), 4.256 (t,  $J = 5.1$  Hz, 2 H), 6.711 (m, 2 H), 6.823 (m, 2 H), 6.981 (m, 3 H), 7.292 (m, 1 H). Anal. Calcd for  $C_{20}H_{25}ClFNO_2$ : C, 65.66; H, 6.89; N, 3.83. Found: C, 65.29; H, 6.85; N, 3.79.

## Example 113

10 4-(3-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrochloride

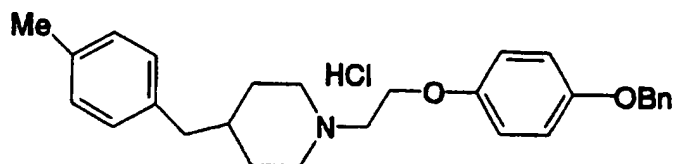


15 From a mixture of 4-(3-fluorobenzyl)piperidine hydrochloride (500 mg, 2.18 mmol), 2-(4-fluorophenoxy)ethyl bromide (501 mg, 2.29 mmol) and  $K_2CO_3$  (615 mg, 4.45 mmol) in  $CH_3CN$  (20 mL) was obtained the title compound as a fluffy, colorless, crystalline solid (360 mg, 81%): mp 155-157 °C,  $^1H$  NMR ( $CDCl_3$ ) 1.65-1.90 (m, 3H), 1.98-2.16 (m, 2H), 2.62 (d,  $J = 7.2$  Hz, 2H), 2.65-2.85 (m, 2H), 3.20-3.53 (m, 2H), 3.67 (d,  $J = 12$  Hz, 2H), 4.51 (t,  $J = 4.5$  Hz, 2H), 6.78-7.10 (m, 7H), 7.19-7.28 (m, 1H), 12.64 (bs, 1H); Anal. Calcd for  $C_{20}H_{24}ClF_2NO$ : C, 65.30; H, 6.58; N, 3.81. Found: C, 65.35; H, 6.58; N, 3.77.

## Example 114

1-[2-(4-Benzyloxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidine hydrochloride

5



A) 4-(4-Methylbenzyl)piperidine hydrochloride was prepared in four steps from triphenylphosphine and 4-methylbenzyl bromide as a white solid, mp 209-211 °C. <sup>1</sup>H NMR (CHCl<sub>3</sub>) 1.696 (m, 3 H), 1.817 (m, 2 H), 2.316 (s, 3 H), 2.546 (m, 2 H), 2.779 (m, 2 H), 3.437 (d, J = 8.7 Hz, 2 H), 6.991 (d, J = 7.8 Hz, 2 H), 7.054 (d, J = 7.8 Hz, 2 H), 9.3 (brs, 1 H), 9.6 (brs, 1 H).

15

B) 1-[2-(4-Benzyloxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidine. From a mixture of 2-(4-benzyloxyphenoxy)ethyl bromide (0.61 g, 2.0 mmol), 4-(4-methylbenzyl)piperidine hydrochloride (0.45 g, 2.0 mmol), potassium carbonate (0.69 g, 5.0 mmol) in 20 mL of acetonitrile was obtained 650 mg (72%) of the title compound, mp 194-196 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.70 (m, 1 H), 1.803 (m, 2 H), 2.025 (m, 2 H), 2.313 (s, 3 H), 2.569 (d, J = 6.9 Hz, 2 H), 2.724 (m, 2 H), 3.337 (m, 2 H), 3.629 (d, J = 11.4 Hz, 2 H), 4.485 (s, 2 H), 5.006 (s, 2 H), 6.810 (d, J = 10.8 Hz, 2 H), 6.875 (d, J = 10.8 Hz, 2 H), 6.993 (d, J = 7.8 Hz, 2 H), 7.081 (d, J = 7.8 Hz, 2 H), 7.315-7.393 (m, 5 H), 12.507 (brs, 1 H).

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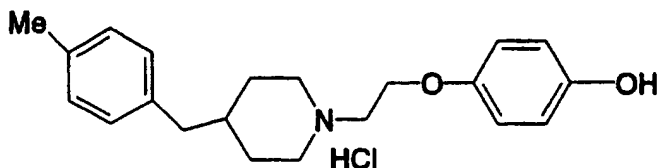


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## Example 115

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidine hydrochloride

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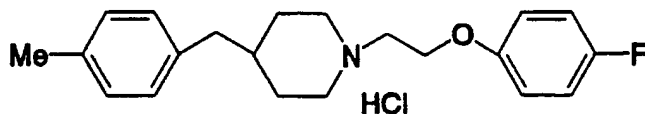
A mixture of 1-[2-(4-benzyloxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidine hydrochloride (250 mg, 0.55  
10 mmol) in 25 mL of ethanol with 60 mg of 20% Pd(OH)<sub>2</sub> was  
hydrogenated at 30 psi of hydrogen to give 140 mg (88%)  
of the title compound, mp 198-200 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD)  
1.6 (m, 2 H), 1.881-1.923 (m, 3 H), 2.288 (s, 3 H),  
2.572 (d, J = 6.6 Hz, 2 H), 3.06 (m, 2 H), 3.473 (m, 2  
15 H), 3.61 (m, 2 H), 4.243 (t, J = 5.1 Hz, 2 H), 6.709  
(dd, J<sub>1</sub> = 2.4 Hz, J<sub>2</sub> = 6.6 Hz, 2 H), 6.830 (dd, J<sub>1</sub> = 2.4  
Hz, J<sub>2</sub> = 6.6 Hz, 2 H), 7.703 (m, 4 H). Anal. Calcd for  
C<sub>21</sub>H<sub>23</sub>ClNO<sub>2</sub>·0.5H<sub>2</sub>O: C, 68.00; H, 7.88; N, 3.78. Found: C,  
68.14; H, 7.65; N, 3.72.

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## Example 116

1-(2-(4-Fluorophenoxy)ethyl)-4-(4-methylbenzyl)piperidine hydrochloride

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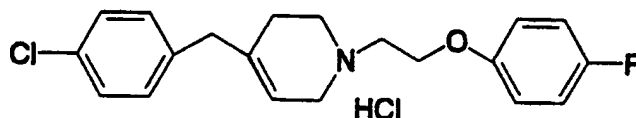
From a mixture of 4-(4-methylbenzyl)piperidine (500 mg,  
2.21 mmol), 2-(4-fluorophenoxy)ethyl bromide (508 mg,  
30 2.32 mmol) and K<sub>2</sub>CO<sub>3</sub> (626 mg, 4.53 mmol) in CH<sub>3</sub>CN (20 mL)  
was obtained the title compound as colorless plates  
(293 mg, 63%), mp 189-191°C, <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.60-2.12  
(m, 5H), 2.31 (s, 3H), 2.57 (d, J = 7.2 Hz, 2H), 2.62-

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2.82 (m, 2H), 3.20-3.55 (m, 2H), 3.65 (d,  $J = 12$  Hz, 2H), 4.51 (t,  $J = 4.5$  Hz, 2H), 6.78-6.84 (m, 2H), 6.92-7.02 (m, 6H), 7.08 (d,  $J = 8.1$  Hz, 2H), 12.56 (bs, 1H);  
Anal. Calcd for  $C_{21}H_{27}ClFNO$ : C, 69.31; H, 7.48; N, 3.85.  
5 Found: C, 69.49; H, 7.39; N, 3.88.

## Example 117

10 4-(4-Chlorobenzyl)-1-(2-(4-fluorophenoxy)-1,2,5,6-tetrahydropyridine hydrochloride



A) 4-(4-Chlorobenzyl)-1,2,5,6-tetrahydropyridine  
15 hydrochloride. A suspension of  $LiAlH_4$  (3.60 g, 95.0 mmol) in dry ether (from  $LiAlH_4$ ) was prepared under  $N_2$ . To this stirred suspension, a solution of  $AlCl_3$  (4.00 g, 30.0 mmol) in dry ether (75 mL) was added with stirring and ice bath cooling over 10 min under  $N_2$ . After  
20 addition, the ice bath was removed and the suspension was allowed to stir 1 hr at 25 °C. To the resulting suspension, a solution of 4-(4-chlorobenzyl)pyridine (12.2 g, 60.0 mmol) in dry ether (50 mL) was added at 25 °C over 3 min. After addition, the resulting  
25 suspension was stirred at reflux for 4 h. The reaction was allowed to cool to 25 °C. The excess hydride was quenched by the very careful addition of 10% HCl (100 mL) with stirring and ice bath cooling. After  
addition, the layers were separated and the ether  
30 portion was extracted with 10% HCl (2 x 75 mL). The combined aqueous portion was made basic by the addition of concd  $NH_4OH$  (100 mL) to give a colorless suspension. The suspension was extracted with ether (4 x 100 mL). The extract was dried over  $Na_2SO_4$ , filtered and the  
35 solvent removed to give a yellow liquid (~13 g). The liquid was distilled in vacuo employing a 15 cm

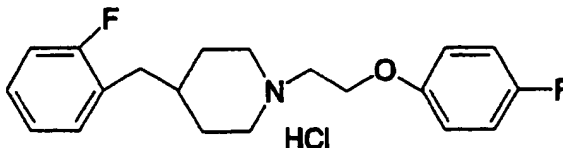
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fractionating column. A fraction was collected between 125-133 °C, 0.005 Torr to yield a colorless liquid (10.5 g, 84%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.51 (s, 1H), 1.89 (s, 2H), 2.90 (t, *J* = 5.7 Hz, 2H), 3.22 (s, 2H), 3.31 (s, 2H), 5.37-5.46 (m, 1H), 7.08 (d, *J* = 7.8 Hz, 2H), 7.22 (d, *J* = 7.8 Hz, 2H). The free base was converted to the hydrochloride salt as large colorless plates (7.52 g, 61%): mp 210-212 °C, <sup>1</sup>H NMR (D<sub>2</sub>O) 2.17-2.26 (m, 2H), 3.25 (t, *J* = 6.3 Hz, 2H), 3.34 (s, 2H), 3.61-3.66 (m, 2H), 5.47-5.54 (m, 1H), 7.20 (d, *J* = 8.4 Hz, 2H), 7.33 (d, *J* = 8.4 Hz, 2H).

B) From a mixture of 4-(4-chlorobenzyl)-1,2,5,6-tetrahydropyridine hydrochloride (500 mg, 2.05 mmol), 2-(4-fluorophenoxy)ethyl bromide (471 mg, 2.15 mmol) and K<sub>2</sub>CO<sub>3</sub> (580 mg, 4.20 mmol) in CH<sub>3</sub>CN (15 mL) was obtained the title compound as a near colorless crystalline solid (311 mg, 69%): mp 174-175 °C, <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.21-2.35 (m, 1H), 2.72-2.88 (m, 1H), 3.03-3.17 (m, 1H), 3.27-3.65 (m, 6H), 3.99 (d, *J* = 16 Hz, 1H), 4.48-4.62 (m, 2H), 5.38 (s, 1H), 6.80-6.86 (m, 2H), 6.94-7.01 (m, 2H), 7.10 (d, *J* = 8.1 Hz, 2H), 7.28 (d, *J* = 8.1 Hz, 2H), 13.00 (bs, 1H); Anal. Calcd for C<sub>20</sub>H<sub>22</sub>Cl<sub>2</sub>FNO: C, 62.83; H, 5.80; N, 3.66. Found: C, 62.95; H, 5.68; N, 3.71.

## Example 118

4-(2-Fluorobenzyl)1-(2-(4-fluorophenoxy)ethyl)piperidine hydrochloride



A) 4-(2-Fluorobenzoyl)pyridine. A solution of 2-bromofluorobenzene (19.2 g, 110 mmol) in dry THF (200

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mL) was prepared under  $N_2$  in a flame dried, 1 L, 3 neck, reaction flask. The stirred solution was cooled in a dry ice/acetone ( $-78^\circ\text{C}$ ) bath for 5 min under  $N_2$ . To this cold solution a solution of *n*-butyl lithium in 5 hexanes (55 mL, 2.20 M, 121 mmol) was added via a syringe with stirring over a 15 min period. After addition, the solution was allowed to stir for 5 min at  $-78^\circ\text{C}$ . To this cold, stirred solution a solution of 4-cyanopyridine (10.4 g, 100 mmol) in dry THF (200 mL) 10 was added from an addition funnel over a 30 min period. After addition, the cold bath was removed and the solution was stirred until the reaction temperature was estimated to be between 10 and  $20^\circ\text{C}$ . The reaction mixture was added to ice  $H_2O$  (500 mL) containing  $NH_4Cl$  15 (20 g) to give a deep red solution. The solution was extracted with ether (3 x 200 mL). The red ether solution was then extracted with 10% aqueous HCl (200 mL and 2 x 100 mL) to give a deep red aqueous solution. The pH of this solution was adjusted to  $\sim 10$  with concd 20  $NH_4OH$ . The mixture was extracted with ether (3 x 100 mL). The extract was washed with  $H_2O$  (300 mL), dried over  $Na_2SO_4$ , and the solvent was removed to give a red oil (17.2 g). The oil was purified by Kugelrohr distillation (OT  $80-90^\circ\text{C}$ , 0.005 Torr). The collected 25 product solidified to yield the title compound as a pale yellow solid (12.6 g, 63%): mp  $59-61^\circ\text{C}$ ;  $^1H$  NMR ( $CDCl_3$ ) 7.10-7.36 (m, 2H), 7.50-7.70 (m, 4H), 8.10 (d,  $J$  = 5.7 Hz, 2H).

30 B) 4-(2-fluorobenzyl)pyridine. A suspension of 4-(2-fluorobenzoyl)pyridine (12.6 g, 62.6 mmol) in ethylene glycol (50 mL) was prepared in an open 250 mL beaker. To the stirred suspension anhydrous hydrazine (8.62 g, 269 mmol) followed by solid NaOH (10.8 g, 269 mmol) 35 were added. The beaker was placed in an oil bath ( $50^\circ\text{C}$ ). The reaction mixture was stirred while the temperature of the oil bath was raised to  $80-85^\circ\text{C}$  at

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which point the reaction foamed vigorously. After foaming subsided, the temperature was raised to 160 °C and was stirred an additional hour to give a pale orange mixture. The reaction mixture was allowed to cool to 25°C to give a thick honey. The honey was dissolved in H<sub>2</sub>O (200 mL) and the resulting mixture was extracted with ether (3 x 75 mL). The extract was washed with H<sub>2</sub>O (200 mL), dried over Na<sub>2</sub>SO<sub>4</sub> and the ether was removed to give a yellow liquid (11.9 g). The liquid was distilled in vacuo (0.005 Torr). A fraction was collected (78-96 °C) to yield the title compound as a pale yellow liquid (5.83 g, 50%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.99 (s, 2H), 7.00-7.30 (m, 6H), 8.49 (d, J = 5.4 Hz, 2H).

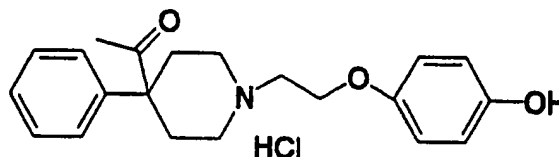
15 C) 4-(2-Fluorobenzyl)piperidine hydrochloride. A mixture of 4-(2-fluorobenzyl)pyridine (5.83 g, 31.1 mmol) in a solution of MeOH (100 mL) and concd HCl (5.5 mL) with PtO<sub>2</sub> (150 mg) was hydrogenated at 20 to 30 psi to yield the title compound as a colorless powder (6.66 g, 93%): mp 187-188°C. <sup>1</sup>H NMR (D<sub>2</sub>O) 1.34-1.54 (m, 2H), 1.78-1.98 (m, 3H), 2.63 (d, J = 6.6 Hz, 2H), 2.89 (td, J = 13 and 3.0 Hz, 2H), 3.32-3.43 (m, 2H), 3.78 (s, 3H), 7.06-7.17 (m, 2H), 7.23-7.31 (m, 2H).

25 D) 4-(2-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrochloride. From A mixture of 4-(2-fluorobenzyl)piperidine hydrochloride (500 mg, 2.18 mmol), 2-(4-fluorophenoxy)ethyl bromide (502 mg, 2.29 mmol) and K<sub>2</sub>CO<sub>3</sub> (618 mg, 4.47 mmol) in CH<sub>3</sub>CN (20 mL) was obtained the title compound as a colorless crystalline solid (470 mg, 64%), mp 159-160 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.70-2.22 (m, 5H), 2.62-2.88 (m, 4H), 3.20-3.50 (m, 2H), 3.60-3.75 (m, 2H), 4.52 (t, J = 4.5 Hz, 2H), 6.78-7.28 (m, 8H), 12.64 (bs, 1H); Anal. Calcd for C<sub>20</sub>H<sub>24</sub>ClF<sub>2</sub>NO: C, 65.30; H, 6.58; N, 3.81. Found: C, 65.25; H, 6.46; N, 3.74.

## Example 119

## 4-Acetyl-1-(2-(4-hydroxyphenoxy)ethyl)-4-phenylpiperidine hydrochloride

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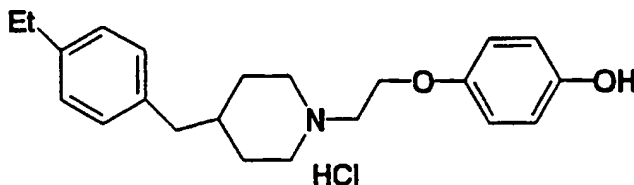
A) 4-Acetyl-1-(2-(4-methoxyphenoxy)ethyl)-4-phenylpiperidine. From a mixture of 4-acetyl-4-phenylpiperidine hydrochloride (600 mg, 2.50 mmol), 2-(4-methoxyphenoxy)ethyl bromide (605 mg, 2.62 mmol) and  $K_2CO_3$  (708 mg, 5.12 mmol) in  $CH_3CN$  (20 mL) was obtained a beige solid (780 mg, 88%): mp 69-70 °C.  $^1H$  NMR ( $CDCl_3$ ) 1.91 (s, 3H), 2.03-2.16 (m, 2H), 2.32-2.54 (m, 4H), 2.74 (t,  $J$  = 6.0 Hz, 2H), 2.78-2.90 (m, 2H), 3.76 (s, 3H), 4.04 (t,  $J$  = 6.0 Hz, 2H), 8.30 (d,  $J$  = 1.2 Hz, 4H), 7.22-7.38 (m, 5H).

B) From 4-acetyl-1-(2-(4-methoxyphenoxy)ethyl)-4-phenylpiperidine (770 mg, 2.18 mmol) in dry  $CH_2Cl_2$  (20 mL) and  $BBr_3$  in  $CH_2Cl_2$  (8 mL, 1 M) was obtained the title compound as a colorless granular solid (310 mg, 38%): mp 210-212 °C.  $^1H$  NMR ( $CD_3OD$ ) 1.98 (s, 3H), 2.10-2.55 (m, 2H), 2.76-3.30 (m, 4H), 3.54 (bs, 2H), 3.60-3.84 (m, 2H), 4.27 (bs, 2H), 6.74 (d,  $J$  = 9.0 Hz, 2H), 6.85 (d,  $J$  = 8.4 Hz, 2H), 7.32-7.50 (m, 5H). Anal Calcd for  $C_{21}H_{26}ClNO_3 \cdot 0.1 H_2O$ : C, 66.78 H, 6.99; N, 3.71. Found: C, 66.64; H, 6.71; N, 3.65.

## Example 120

1- [2- (4-Hydroxyphenyl)ethoxy] -4- (4-ethylbenzyl)piperidine hydrochloride

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A) 4- (4-Ethylbenzyl)piperidine hydrochloride was prepared from triphenylphosphine and 4-ethylbenzyl bromide in four steps as a white solid, mp 175-177 °C. <sup>1</sup>H NMR (CHCl<sub>3</sub>) 1.219 (t, J = 7.8 Hz, 3 H), 1.707 (m, 2 H), 1.828 (m, 3 H), 2.553-2.654 (m, 4 H), 2.775 (m, 2 H), 3.436 (d, J = 11.7 Hz, 2 H), 7.017 (d, J = 7.8 Hz, 2 H), 7.109 (d, J = 7.8 Hz, 2 H), 9.3 (s, 1 H), 9.6 (s, 1 H). Anal. Calcd for C<sub>14</sub>H<sub>22</sub>ClN: C, 70.13; H, 9.25; N, 5.84. Found: C, 69.88; H, 9.48; N, 5.71.

B) 1- [2- (4-Benzyloxyphenoxy)ethoxy] -4- (4-ethylbenzyl)piperidine hydrochloride. From a mixture of 2- (4-benzyloxyphenoxy)ethyl bromide (0.46 g, 1.5 mmol), 4-ethylbenzylpiperidine hydrochloride (0.359 g, 1.5 mmol), potassium carbonate (0.52 g, 3.75 mmol) in 50 mL of acetonitrile was obtained 0.51 g (73%) of the title product. mp 186-188 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.218 (t, J = 7.8 Hz, 3 H), 1.68 (m, 1 H), 1.805 (m, 2 H), 2.030 (m, 2 H), 2.320 (m, 3 H), 2.480 (m, 4 H), 2.730 (m, 2 H), 3.338 (m, 2 H), 3.625 (d, J = 11.4 Hz, 2 H), 4.482 (s, 2 H), 5.004 (s, 2 H), 6.812 (d, J = 10.8 Hz, 2 H), 6.873 (d, J = 10.8 Hz, 2 H), 6.992 (d, J = 7.8 Hz, 2 H), 7.083 (d, J = 7.8 Hz, 2 H), 7.320-7.389 (m, 5 H), 12.62 (s, 1 H).

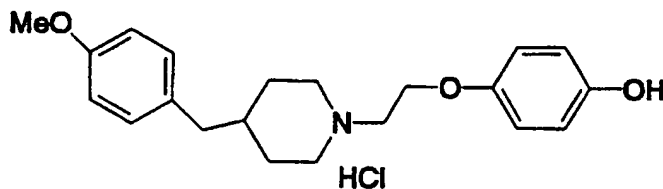
C) A mixture of 1- [2- (4-benzyloxyphenoxy)ethyl] -4- (4-ethylbenzyl)piperidine hydrochloride (510 mg, 1.095

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mmol) in 50 mL of methanol and 128 mg of 20% Pd(OH)<sub>2</sub> was hydrogenated at 30 psi of hydrogen to give 385 mg (94%) of the title compound as white-off solid, mp 174-176 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.206 (t, J = 7.8 Hz, 3 H), 1.564 (s, 2 H), 1.901-1.943 (m, 3 H), 2.595 (m, 4 H), 3.033 (m, 2 H), 3.501 (m, 2 H), 3.667 (m, 2 H), 4.260 (s, 2 H), 6.721 (d, J = 9.0 Hz, 2 H), 6.842 (d, J = 9.0 Hz, 2 H), 6.842 (d, J = 9.0 Hz, 2 H), 7.124 (m, 4 H). Anal. Calcd for C<sub>22</sub>H<sub>30</sub>ClNO<sub>2</sub>: C, 70.29; H, 8.04; N, 3.73. Found: 10 C, 70.06; H, 8.07; N, 3.50. (HPLC >98%).

## Example 121

15 1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-methoxybenzyl)piperidine hydrochloride



The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide (0.384 g, 1.25 mmol), 4-(4-methoxybenzyl)piperidine (0.257 g, 1.25 mmol) and potassium carbonate (0.43 g, 3.12 mmol) in two steps as a white solid, mp 123-125 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.554 (m, 2 H), 1.891 (m, 3 H), 2.567 (m, 2 H), 3.029 (m, 2 H), 25 3.501 (m, 2 H), 3.637 (m, 2 H), 3.759 (s, 3 H), 4.262 (s, 2 H), 6.743 (m, 2 H), 6.839 (m, 4 H), 7.111 (m, 2 H). Anal. Calcd for C<sub>21</sub>H<sub>28</sub>ClNO<sub>3</sub>·0.3H<sub>2</sub>O: C, 65.80; H, 7.52; N, 3.65. Found: C, 65.56; H, 7.57; N, 3.60.

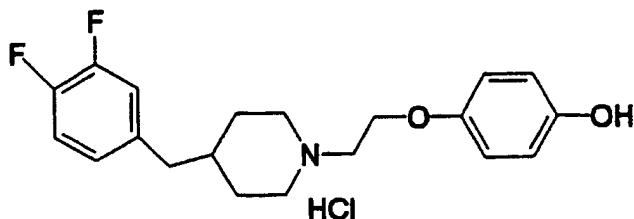


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## Example 122

1- [2- (4-Hydroxyphenoxy) ethyl] -4- (3,4-  
difluorobenzyl) piperidine hydrochloride

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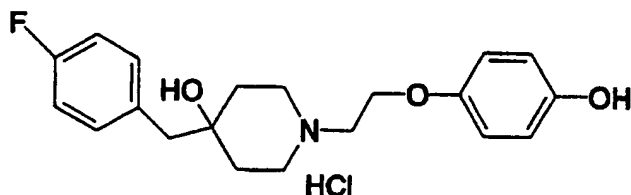
A) 4- (3,4-Difluorobenzyl) piperidine hydrochloride was prepared from triphenylphosphine and 3,4-  
10 difluorobenzyl bromide in four steps as a white solid, mp 174-175 °C. <sup>1</sup>H NMR (CHCl<sub>3</sub>) 1.704-1.827 (m, 5 H), 2.564 (m, 2 H), 2.798 (m, 2 H), 3.457 (d, J = 8.1 Hz, 2 H), 6.833 (m, 1 H), 6.891 (m, 1 H), 7.052 (m, 1 H), 9.38 (s, 1 H), 9.60 (s, 1 H). Anal. Calcd for  
15 C<sub>12</sub>H<sub>16</sub>ClF<sub>2</sub>N: C, 58.18; H, 6.51; N, 5.65. Found: C, 57.89; H, 6.43; N, 5.59.

B) The title compound was prepared in two steps from  
2- (4-benzyloxyphenoxy) ethyl bromide, 3,4-  
20 difluorobenzyl piperidine hydrochloride and potassium carbonate in two steps as an off white solid, mp 180-182 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.595 (m, 2 H), 1.889 (d, J = 12.0 Hz, 3 H), 2.607 (m, 2 H), 3.051 (m, 2 H), 3.513 (m, 2 H), 3.647 (d, J = 10.2 Hz, 2 H), 4.272 (s, 2 H),  
25 6.718 (d, J = 8.7 Hz, 2 H), 6.841 (d, J = 8.7 Hz, 2 H), 7.017 (m, 1 H), 7.170 (m, 2 H). Anal. Calcd for C<sub>20</sub>H<sub>24</sub>ClF<sub>2</sub>NO<sub>2</sub>·0.6H<sub>2</sub>O: C, 60.98; H, 6.44; N, 3.55. Found: C, 60.72; H, 6.38; N, 3.45.

## Example 123

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-fluorobenzyl)-4-hydroxy-piperidine hydrochloride

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A) 1-[2-(4-Benzoyloxyphenoxy)ethyl]-4-(4-fluorobenzyl)-4-hydroxypiperidine. A mixture of 2-(4-benzoyloxyphenoxy)ethyl bromide (1.075 g, 3.5 mmol), 4-(4-fluorobenzyl)-4-hydroxypiperidine (0.778 g, 3.7 mmol), potassium carbonate (1.28 g, 9.25 mmol) in 50 mL of acetonitrile was allowed to reflux for 12 h. The inorganic salt was removed through a short column of silica gel and washed with ethyl acetate (3 x 25 mL). The combined filtrate was evaporated in vacuo to give a crude product, which was purified by flash chromatography (5% methanol in ethyl acetate), giving 0.8 g (53%) of the title compound as a pale yellow oil.

<sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.544 (m, 2 H), 1.80 (m, 2 H), 2.50 (m, 2 H), 2.834 (m, 3 H), 3.484 (s, 4 H), 4.079 (t, J = 4.8 Hz, 2 H), 5.008 (s, 2 H), 6.810 (d, J = 9.0 Hz, 2 H), 6.878 (d, J = 9.0 Hz, 2 H), 6.997 (m, 2 H), 7.135 (m, 2 H), 7.350 (m, 5 H).

25

B) 1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-fluorobenzyl)-4-hydroxypiperidine hydrochloride. To a solution of 1-[2-(4-benzoyloxyphenoxy)ethyl]-4-(4-fluorobenzyl)-4-hydroxypiperidine (0.8 g, 1.8 mmol) in 25 mL of methanol was added 200 mg of 20% Pd(OH)<sub>2</sub>. The resulting mixture was hydrogenated at 20 psi of hydrogen for 3 h. The catalyst was removed through a short column of celite (5 g) and washed with methanol (3 x 15 mL), to which was added 4 mL of 1 M HCl in methanol. The

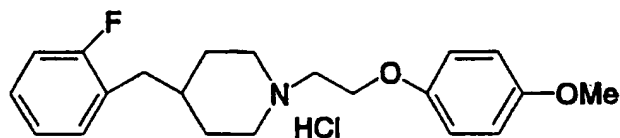
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resulting solution was allowed to stir at rt for 10 min. and methanol was evaporated in vacuo to give a residue, to which 50 mL of ether was added. The resulting mixture was stirred overnight. A white solid 5 was collected by filtration and dried in vacuo, giving 550 mg (80%) of the title compound, mp 128-130 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.732 (m, 2 H), 1.935 (m, 2 H), 2.825 (m, 2 H), 3.328 (m, 2 H), 3.486 (m, 4 H), 4.265 (s, 2 H), 6.719 (m, 2 H), 6.840 (m, 2 H), 7.033 (m, 2 H), 7.238 10 (m, 2 H). Anal. Calcd for C<sub>20</sub>H<sub>25</sub>ClFNO<sub>3</sub>·0.5H<sub>2</sub>O: C, 61.46; H, 6.70; N, 3.58. Found: C, 61.50; H, 6.64; N, 3.59.

## Example 124

15 4-(2-Fluorobenzyl)-1-(2-(4-methoxyphenoxy)ethyl)piperidine hydrochloride

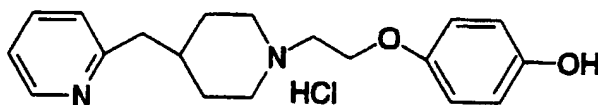


20 From a mixture of 4-(2-fluorobenzyl)piperidine hydrochloride (407 mg, 1.77 mmol), 2-(4-methoxyphenoxy)ethyl bromide (430 mg, 1.86 mmol) and K<sub>2</sub>CO<sub>3</sub> (501 mg, 3.63 mmol) in CH<sub>3</sub>CN (20 mL) was obtained the title compound as colorless flakes (387 mg): mp 25 151-152 °C, <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.74-1.88 (m, 3H), 1.98-2.16 (m, 2H), 2.65 (d, J = 6.9 Hz, 2H), 2.68-2.84 (m, 2H), 3.26-3.48 (m, 2H), 3.61-3.70 (m, 2H), 3.75 (s, 3H), 4.74 (t, J = 4.2 Hz, 2H), 6.80 (s, 4H), 6.96-7.24 (m, 4H), 12.53 (bs, 1H); Anal. Calcd for C<sub>21</sub>H<sub>27</sub>ClFNO<sub>2</sub>: C, 30 66.39; H, 7.16; N, 3.69. Found: C, 66.29; H, 6.94; N, 3.59.

## Example 125

1- (2- (4-Hydroxyphenoxy) ethyl) -4- (2-picolyl) piperidine  
dihydrochloride

5



A) 1- (2- (4-Methoxyphenoxy) ethyl) isonipecotamide.

From a mixture of isonipecotamide (11.1 g, 86.6 mmol),  
10 2- (4-methoxyphenoxy) ethyl bromide (20.0 g, 86.6 mmol)  
and  $K_2CO_3$  (12.0 g, 86.6 mmol) in  $CH_3CN$  (500 mL) was  
obtained the title compound as beige needles (17.2 g,  
72%): mp 132-134 °C,  $^1H$  NMR ( $CDCl_3$ ) 1.68-1.92 (m, 4H),  
2.06-2.22 (m, 3H), 2.76 (t,  $J$  = 6.0 Hz, 2H), 2.98-3.08  
15 (m, 2H), 3.76 (s, 3H), 4.03 (t,  $J$  = 6.0 Hz, 2H), 5.59  
(bs, 1H), 5.82 (bs, 1H), 6.83 (d,  $J$  = 0.9 Hz, 4H).

B) 4-Cyano-1- (2- (4-methoxyphenoxy) ethyl) piperidine.

To a stirred suspension of 1- (2- (4-  
20 methoxyphenoxy) ethyl) isonipecotamide (10.0 g, 35.9  
mmol) in  $CHCl_3$  (80 mL) neat  $SOCl_2$  (30 mL) was added drop  
wise over 5 min. The resulting suspension was heated at  
reflux with stirring under  $N_2$  for 1 h. The reaction was  
allowed to cool to 25 °C and the volatile portion was  
25 removed to give a yellow syrup. The syrup was  
partitioned between  $CHCl_3$  and  $H_2O$  (200 mL) each. The  
stirred yellow mixture was made basic by the addition  
of concd  $NH_4OH$  (50 mL) to give a pink mixture. The  
layers were separated and the aqueous portion was  
30 extracted with  $CHCl_3$  (2 x 50 mL). The combined organic  
portion was washed with 10%  $NH_4OH$ ,  $H_2O$  and brine (200 mL  
each), was filtered through cotton and the solvent was  
removed to give a red oil that partially solidified  
upon standing. The product was purified on silica gel  
35 (3.5 x 25 cm) with  $CHCl_3$ , then 2% EtOH/98%  $CHCl_3$ , elution  
to yield the title compound as an amber oil that

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solidified to a beige solid upon standing (6.8 g, 73%): mp 49-51 °C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.78-2.03 (m, 4H), 2.40-2.54 (m, 2H), 2.58-2.84 (m, 5H), 3.76 (s, 3H), 4.03 (t, *J* = 5.7 Hz, 2H), 6.83 (s, 4H).

5

C) 1-(2-(4-Methoxyphenoxy)ethyl)-4-(2-picoloyl)piperidine was prepared from 2-bromopyridine (1.34 g, 8.45 mmol), *n*-BuLi (4.2 mL, 9.30 mmol, 2.2 M solution in hexanes) and 4-cyano-1-(2-(4-methoxyphenoxy)ethyl)piperidine (2.00 g, 7.68 mmol) as an orange oil (1.40 g, 54%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.72-1.98 (m, 4H), 2.32 (td, *J* = 12 and 2.7 Hz, 2H), 2.82 (t, *J* = 6.0 Hz, 2H), 3.02-3.12 (m, 2H), 7.76 (s, 3H), 3.78-3.90 (m, 1H), 4.07 (t, *J* = 6.0 Hz, 2H), 6.76-6.88 (m, 4H), 7.45 (ddd, *J* = 7.5, 4.8 and 1.2 Hz, 1H), 7.82 (td, *J* = 7.5 and 1.8 Hz, 1H), 8.02 (dt, *J* = 7.8 and 0.9 Hz, 1H), 8.67 (dq, *J* = 7.8 and 0.9 Hz, 1H).

D) 1-(2-(4-Methoxyphenoxy)ethyl)-4-(2-picolyl)piperidine. 1-(2-(4-methoxyphenoxy)ethyl)-4-(2-picoloyl)piperidine (1.40 g, 4.11 mmol) was reduced by anhydrous hydrazine (565 mg, 17.6 mmol) to yield the title compound as an amber oil (1.10 g, 82%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.30-1.46 (m, 2H), 1.63 (d, *J* = 13 Hz, 2H), 1.72-1.88 (m, 1H), 2.06 (td, *J* = 12 and 2.4 Hz, 2H), 2.70 (d, *J* = 7.2 Hz, 2H), 2.74 (t, *J* = 6.0 Hz, 2H), 2.90-3.00 (m, 2H), 3.75 (s, 3H), 4.03 (t, *J* = 6.0 Hz, 2H), 6.81 (d, *J* = 1.2 Hz, 4H), 7.05-7.12 (m, 2H), 7.56 (td, *J* = 7.5 and 2.1 Hz, 1H), 8.53 (dd, *J* = 5.4 and 1.8 Hz, 1H).

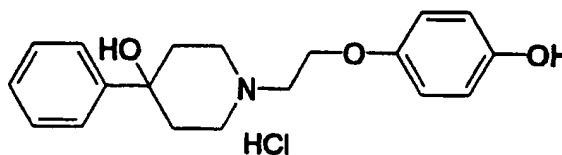
E) 1-(2-(4-Hydroxyphenoxy)ethyl)-4-(2-picolyl)piperidine dihydrochloride From 1-(2-(4-methoxyphenoxy)ethyl)-4-(2-picolyl)piperidine (536 mg, 1.64 mmol) and BBr<sub>3</sub> in CH<sub>2</sub>Cl<sub>2</sub> (6 mL, ~1 M) was obtained the title compound as a slightly hygroscopic brown powder (217 mg): mp 55-62 °C; <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.70-2.01

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(m, 4H), 2.14-2.40 (m, 1H), 3.04-3.28 (m, 4H), 3.54 (t,  $J = 4.5$  Hz, 2H), 3.70 (d,  $J = 13$  Hz, 2H), 4.30 (t,  $J = 4.5$  Hz, 2H), 6.73 (d,  $J = 9.3$  Hz, 2H), 6.85 (d,  $J = 9.0$  Hz, 2H), 7.98 (t,  $J = 6.6$  Hz, 1H), 8.06 (d,  $J = 8.1$  Hz, 5 1H), 8.58 (t,  $J = 7.8$  Hz, 1H), 8.79 (d,  $J = 5.4$  Hz, 1H).

## Example 126

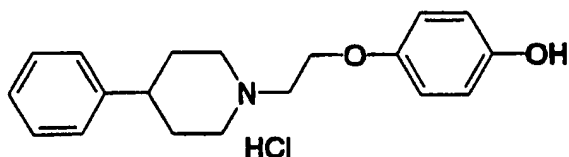
- 10 1-[2-(4-Hydroxyphenoxy)ethyl]-4-hydroxy-4-phenylpiperidine hydrochloride



- 15 The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide (0.384 g, 1.25 mmol), 4-hydroxy-4-phenylpiperidine (0.222 g, 1.25 mmol) and potassium carbonate (0.431 g, 3.12 mmol) in two steps as white solid (190 mg), mp 208-210 °C.  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ )
- 20 2.020 (m, 3 H), 2.420 (m, 2 H), 2.95 (m, 1 H), 3.614 (m, 3 H), 3.755 (m, 1 H), 4.322 (s, 2 H), 6.730 (d,  $J = 9.0$  Hz, 2 H), 6.873 (d,  $J = 9.0$  Hz, 2 H), 7.308 (m, 4 H), 7.516 (d,  $J = 7.8$  Hz, 2 H). Anal. Calcd for  $\text{C}_{19}\text{H}_{24}\text{ClNO}_3$ : C, 65.23; H, 6.91; N, 4.00. Found: C, 65.43; 25 H, 7.10; N, 3.90.

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Example 127  
1-[2-(4-Hydroxyphenoxy)ethyl]-4-phenylpiperidine  
hydrochloride



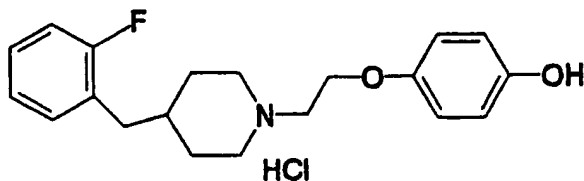
5

The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide (0.377 g, 1.23 mmol), 4-phenylpiperidine hydrochloride (0.20 g, 1.23 mmol) and 10 potassium carbonate (0.423 g, 3.07 mmol) in two steps as a white solid (180 mg), mp 198-200 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 2.114 (m, 4 H), 2.85 (m, 1 H), 3.295 (m, 2 H), 3.588 (m, 2 H), 3.767 (d, J = 10.5 Hz, 2 H), 4.314 (d, J = 5.1 Hz, 2 H), 6.730 (d, J = 8.7 Hz, 2 H), 6.872 (d, 15 J = 8.7 Hz, 2 H), 7.292 (m, 5 H). Anal. Calcd for C<sub>19</sub>H<sub>24</sub>ClNO<sub>2</sub>·0.3H<sub>2</sub>O: C, 67.26; H, 7.31; N, 4.13. Found: C, 67.32; H, 7.34; N, 4.04.

Example 128

20

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(2-fluorobenzyl)piperidine hydrochloride



25

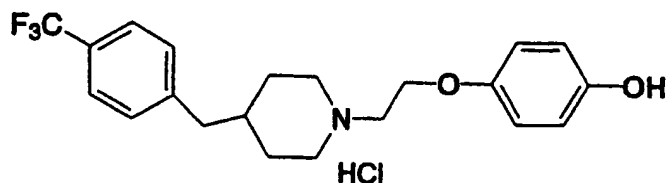
The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide (0.393 g, 1.28 mmol), 4-(2-fluorobenzyl)piperidine hydrochloride (0.294 g, 1.28 mmol) and potassium carbonate (0.442 g, 3.2 mmol) in 30 two steps as an off white solid (0.237 g), mp 196-198 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.629 (m, 2 H), 1.900 (m, 3 H),

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2.704 (m, 2 H), 3.052 (m, 2 H), 3.500 (m, 2 H), 3.612 (m, 2 H), 4.252 (m, 2 H), 6.703 (d,  $J = 9.0$  Hz, 2 H), 6.825 (d,  $J = 9.0$  Hz, 2 H), 7.057-7.248 (m, 2 H), 7.248 (m, 2 H). Anal. Calcd for  $C_{20}H_{23}ClFNO_2 \cdot 1.2H_2O$ : C, 61.70; H, 7.15; N, 3.60. Found: C, 61.45; H, 6.90; N, 3.53.

## Example 129

10 1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-trifluorobenzyl)piperidine hydrochloride



A) 4-(4-Trifluoromethylbenzyl)piperidine hydrochloride  
15 was prepared from triphenylphosphine and 4-trifluoromethylbenzyl bromide in four steps as white solid, mp 208-210 °C.  $^1H$  NMR ( $CHCl_3$ ) 1.760-1.846 (m, 5 H), 2.662 (s, 2 H), 2.792 (s, 2 H), 3.454 (d,  $J = 11.7$  Hz, 2 H), 7.226 (d,  $J = 7.8$  Hz, 2 H), 7.539 (d,  $J = 7.8$  Hz, 2 H), 9.410 (s, 1 H), 9.660 (s, 1 H). Anal. Calcd for  $C_{13}H_{17}ClF_3N$ : C, 55.82; H, 6.13; N, 5.01. Found: C, 55.46; H, 6.00; N, 5.07.

B) The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide 4-(trifluoromethylbenzyl)piperidine hydrochloride and potassium carbonate in two steps as an off white solid, mp 200-202 °C.  $^1H$  NMR ( $CD_3OD$ ) 1.60 (m, 2 H), 1.893 (m, 3 H), 2.721 (d,  $J = 6.3$  Hz, 2 H), 3.08 (m, 2 H), 3.498 (m, 2 H), 3.629 (m, 2 H), 4.251 (t,  $J = 5.1$  Hz, 2 H), 6.719 (m, 2 H), 6.841 (m, 2 H), 7.398 (d,  $J = 8.1$  Hz, 2 H), 7.591 (d,  $J = 8.1$  Hz, 2 H). Anal. Calcd for  $C_{21}H_{25}ClF_3NO_2$ : C, 60.65; H, 6.06; N, 3.37. Found: C, 60.27; H, 5.80; N, 3.31.

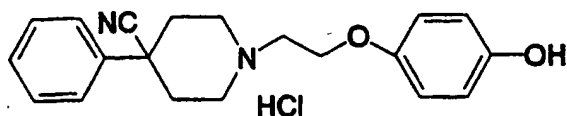


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## Example 130

4-Cyano-1-(2-(4-hydroxyphenoxy)ethyl)-4-phenylpiperidine hydrochloride

5

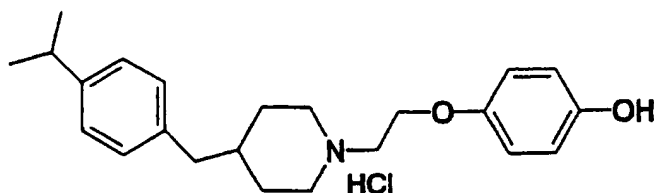


The title compound was prepared from 4-cyano-4-phenylpiperidine hydrochloride (600 mg, 2.69 mmol), 2-(4-methoxyphenoxy)ethyl bromide (653 mg, 2.82 mmol) and  $K_2CO_3$  (761 mg, 5.51 mmol) in two steps as a colorless solid (28 mg, 6%), mp 199-200 °C;  $^1H$  NMR ( $CD_3OD$ ) 2.48-2.64 (m, 4H), 3.48-3.64 (m, 2H), 3.73 (t,  $J$  = 4.8 Hz, 2H), 3.95 (d,  $J$  = 12 Hz, 2H), 4.36 (t,  $J$  = 4.5 Hz, 2H), 15 6.74 (d,  $J$  = 8.7 Hz, 2H), 6.90 (d,  $J$  = 9.0 Hz, 2H), 7.38-7.64 (m, 5H); HRMS calcd for  $C_{20}H_{22}N_2O_2$  322.1681, found 322.1678.

## Example 131

20

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-isopropylbenzyl)piperidine hydrochloride



25

A) 4-(4-Isopropylbenzyl)piperidine hydrochloride was prepared from 4-isopropylbenzyl alcohol in five steps as white solid, mp 183-185 °C.  $^1H$  NMR ( $CHCl_3$ ) 1.221 (d,  $J$  = 7.2 Hz, 6 H), 1.709 (m, 2 H), 1.832 (m, 3 H), 2.552 (m, 2 H), 2.777-2.875 (m, 3 H), 3.434 (d,  $J$  = 11.7 Hz, 2 H), 7.025 (d,  $J$  = 7.8 Hz, 2 H), 7.135 (d,  $J$  = 7.8 Hz, 2 H), 9.30 (s, 1 H), 9.60 (s, 1 H). Anal. Calcd for

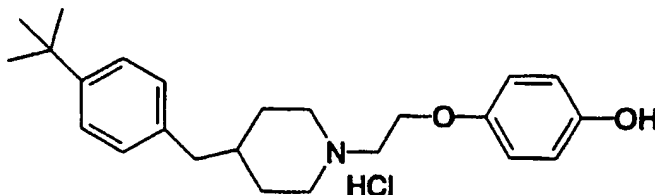
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$C_{13}H_{24}ClN \cdot 0.2H_2O$ : C, 69.98; H, 9.55; N, 5.44. Found: C, 70.06; H, 9.30; N, 5.29.

B) The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide (0.393 g, 1.28 mmol), 4-isopropylbenzylpiperidine hydrochloride (0.325 g, 1.28 mmol) and potassium carbonate (0.444 g, 3.2 mmol) in two steps as white-off solid (385 mg), mp 168-170 °C.  $^1H$  NMR ( $CD_3OD$ ) 1.207 (d,  $J = 6.6$  Hz, 6 H), 1.577 (m, 2 H), 1.893 (m, 3 H), 2.586 (d,  $J = 6.3$  Hz, 2 H), 2.859 (hepta,  $J = 6.6$  Hz, 1 H), 3.038 (brs, 2 H), 3.499 (m, 2 H), 3.607 (m, 2 H), 4.250 (s, 2 H), 6.734 (m, 2 H), 6.821 (m, 2 H), 7.087 (d,  $J = 7.4$  Hz, 2 H), 7.146 (m, 2 H). Anal. Calcd for  $C_{23}H_{32}ClNO_2$ : C, 70.84; H, 8.27; N, 3.59. Found: C, 71.03; H, 7.99; N, 3.56.

## Example 132

20 1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-t-butylbenzyl)piperidine hydrochloride



A) 4-(4-t-Butylbenzyl)piperidine hydrochloride was prepared from 4-t-butylbenzyl alcohol in five steps as white solid, mp 208-210 °C.  $^1H$  NMR ( $CHCl_3$ , 300 MHz)  $\delta$  1.303 (s, 9 H), 1.681 (m, 3 H), 1.841 (m, 2 H), 2.554 (m, 2 H), 2.798 (m, 2 H), 3.435 (d,  $J = 12.3$  Hz, 2 H), 7.036 (d,  $J = 8.1$  Hz, 2 H), 7.293 (d,  $J = 8.1$  Hz, 2 H), 9.30 (s, 1 H), 9.61 (s, 1 H). Anal. Calcd for  $C_{16}H_{26}ClN \cdot 0.3H_2O$ : C, 70.33; H, 9.81; N, 5.13. Found: C, 70.20; H, 9.62; N, 5.03.

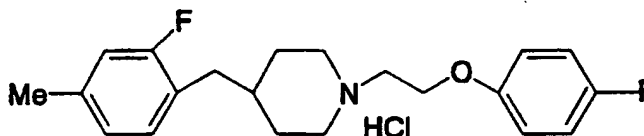
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B) The title compound was prepared from 2-(4-benzyloxyphenoxy)ethyl bromide (0.393 g, 1.28 mmol), 4-t-butylbenzylpiperidine hydrochloride (0.359 g, 1.5 mmol) and potassium carbonate (0.444 g, 3.2 mmol) in two steps as white-off solid (385 mg), mp 178-180 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.292 (s, 9 H), 1.516 (m, 2 H), 1.899 (m, 3 H), 2.582 (d, J = 6.0 Hz, 2 H), 3.023 (m, 2 H), 3.484 (m, 2 H), 3.622 (d, J = 11.7 Hz, 2 H), 4.248 (t, J = 5.4 Hz, 2 H), 6.712 (d, J = 9.0 Hz, 2 H), 6.832 (d, J = 9.0 Hz, 2 H), 7.098 (d, J = 8.1 Hz, 2 H), 7.315 (d, J = 8.1 Hz, 2 H). Anal. Calcd for C<sub>23</sub>H<sub>27</sub>ClNO<sub>2</sub>: C, 71.35; H, 8.48; N, 3.47. Found: C, 71.10; H, 8.21; N, 3.42.

## Example 133

15

4-(2-Fluoro-4-methylbenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrochloride



20

A) 4-(2-Fluoro-4-methylbenzyl)piperidine hydrochloride was prepared from 4-bromo-3-fluorotoluene, n-butyl lithium and 4-cyanopyridine in three steps as a colorless powder, mp 211-213°C; <sup>1</sup>H NMR (D<sub>2</sub>O) 1.34-1.52 (m, 2H), 1.78-1.98 (m, 3H), 2.30 (s, 3H), 2.60 (d, J = 6.6 Hz, 2H), 2.90 (td, J = 13 and 2.7 Hz, 2H), 3.32-3.43 (m, 2H), 6.93-7.01 (m, 2H), 7.11-7.19 (m, 1H).

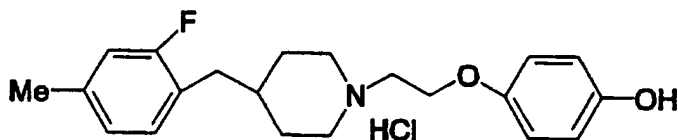
B) The title compound was prepared from 4-(2-fluoro-4-methylbenzyl)piperidine hydrochloride (375 mg, 1.54 mmol), 2-(4-fluorophenoxy)ethyl bromide (355 mg, 1.62 mmol) and K<sub>2</sub>CO<sub>3</sub> (437 mg, 3.16 mmol) as a colorless crystalline solid (362 mg), mp 167-168 °C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.60-1.80 (m, 3H), 1.95-2.15 (m, 2H), 2.30 (s,

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3H), 2.61 (d,  $J = 6.6$  Hz, 2H), 2.65-2.83 (m, 2H), 3.20-3.70 (m, 4H), 4.51 (d,  $J = 4.2$  Hz, 2H), 6.78-7.00 (m, 7H), 12.60 (bs, 1H); Anal. Calcd for  $C_{21}H_{26}ClF_2NO$ : C, 66.05; H, 6.86; N, 3.67. Found: C, 66.09; H, 6.78; N, 5 3.46.

## Example 134

10 4-(2-Fluoro-4-methylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine hydrochloride

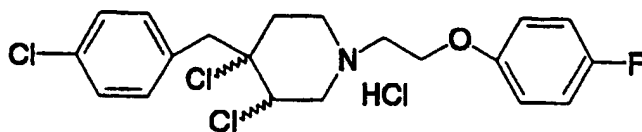


The title compound was prepared from 4-(2-fluoro-4-methylbenzyl)piperidine hydrochloride (375 mg, 1.54 mmol), 2-(4-hydroxyphenoxy)ethyl bromide (352 mg, 1.62 mmol) and  $NaHCO_3$  (265 mg, 3.16 mmol) as a near colorless powder (430 mg): mp 164-165 °C;  $^1H$  NMR ( $CD_3OD$ ) 1.51-1.70 (m, 2H), 1.84-2.00 (m, 3H), 2.31 (s, 3H), 2.63 (d, 20  $J = 5.7$  Hz, 2H), 2.94-3.12 (m, 2H), 3.44-3.70 (m, 4H), 4.26 (t,  $J = 4.8$  Hz, 2H), 6.74 (d,  $J = 9.3$  Hz, 2H), 6.82-6.96 (m, 4H), 7.07-7.14 (m, 1H); Anal. Calcd for  $C_{21}H_{27}ClFNO_2$ : C, 66.39; H, 7.16; N, 3.69. Found: C, 66.62; H, 6.99; N, 3.54.

25

## Example 135

30 3,4-Dichloro-4-(4-chlorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrochloride



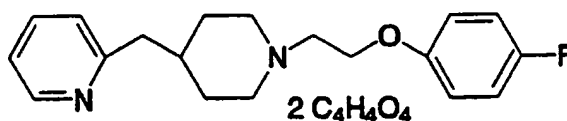
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To a stirred solution of 4-(4-chlorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)-1,2,5,6-tetrahydropyridine hydrochloride (70 mg, 136  $\mu$ mol) in  $\text{CHCl}_3$  (10 mL) a dilute solution of  $\text{Cl}_2$  in  $\text{CCl}_4$  was added in portions. After each addition the reaction was checked by TLC (1% MeOH /  $\text{CHCl}_3$ ).  $\text{Cl}_2$  addition was continued until all the starting material was converted to the much higher  $R_f$  product spot. The reaction mixture was washed with dilute  $\text{NH}_4\text{OH}$  and the organic portion was filtered (cotton). Solvent removal gave a yellow oil. The oil was purified on silica gel with  $\text{CHCl}_3$  elution to give the free base of the title compound as a pale yellow oil (37 mg, 49%). The free base was converted to hydrochloride as a pale beige powder (40 mg): mp 78-83  $^\circ\text{C}$  (foams),  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.98 (d,  $J = 15$  Hz, 1H), 2.95-4.00 (m, 9H), 4.10-4.20 (m, 1H), 4.38-4.75 (m, 2H), 6.79-7.02 (m, 2H), 7.27-7.37 (m, 2H), 12.48 (bs, 1H); HRMS calcd for  $\text{C}_{20}\text{H}_{21}\text{Cl}_3\text{FNO}$  415.0673, found 415.0664.

20

## Example 136

1-(2-(4-Fluorophenoxy)ethyl)-4-(2-picoly) piperidine dimaleic acid salt



25

The title compound was prepared from isonipecotamide, 2-(4-fluorophenoxy)ethyl bromide, and  $\text{K}_2\text{CO}_3$  in four steps as a pale yellow solid, mp 114-115  $^\circ\text{C}$ ;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.56-1.75 (m, 2H), 1.94 (d,  $J = 15$  Hz, 2H), 2.08-2.25 (m, 1H), 2.96-3.18 (m, 4H), 3.33-3.56 (m, 2H), 3.62-3.73 (m, 2H), 4.32 (d,  $J = 4.8$  Hz, 2H), 6.26 (s, 4H), 6.91-7.12 (m, 4H), 7.84-7.94 (m, 2H), 8.48 (td,  $J = 7.8$  and 1.5 Hz, 1H), 8.63 (d,  $J = 6.0$  Hz, 1H);

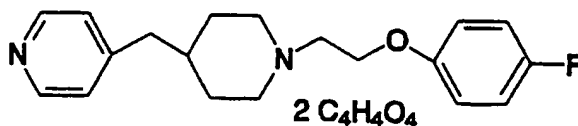
- 168 -

Anal. Calcd for  $C_{27}H_{31}FN_2O_9$ : C, 59.33; H, 5.71; N, 5.12.  
 Found: C, 59.36; H, 5.68; N, 4.94.

## Example 137

5

1-(2-(4-Fluorophenoxy)ethyl)-4-(4-picolyl)piperidine  
 dimaleic acid salt



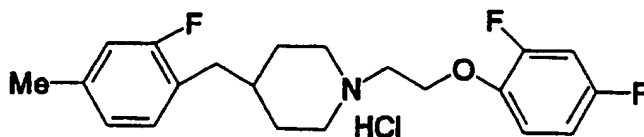
10

The title compound was prepared from 4-bromopyridine hydrochloride, n-BuLi and 4-cyano-1-(2-(4-fluorophenoxy)ethyl)piperidine in two steps as a near colorless solid: mp 108-109 °C;  $^1H$  NMR ( $D_2O$ ) 1.52-1.70 (m, 2H), 1.92 (d,  $J$  = 14 Hz, 2H), 2.04-2.20 (m, 1H), 2.94 (d,  $J$  = 7.2 Hz, 2H), 3.04 (td,  $J$  = 11 and 2.1 Hz, 2H), 3.32-3.56 (m, 2H), 3.60-3.72 (m, 2H), 4.32 (t,  $J$  = 4.8 Hz, 2H), 6.26 (s, 4H), 6.90-7.12 (m, 4H), 7.90 (d,  $J$  = 6.6 Hz, 2H), 8.64 (d,  $J$  = 6.9 Hz, 2H); Anal. Calcd for  $C_{27}H_{31}FN_2O_9$ : C, 59.33; H, 5.71; N, 5.12. Found: C, 59.37; H, 5.75; N, 5.01.

## Example 138

25

4-(2-Fluoro-4-methylbenzyl)-1-(2-(2,4-difluorophenoxy)ethyl)piperidine hydrochloride



30 The title compound was prepared from 4-(2-fluoro-4-methylbenzyl)piperidine hydrochloride (300 mg, 1.23 mmol), 2-(2,4-difluorophenoxy)ethyl bromide (321 mg, 1.35 mmol) and  $K_2CO_3$  (357 mg, 2.58 mmol) as colorless

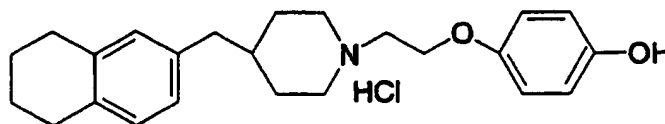
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flakes (326 mg): mp 180-182 °C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.65-1.90 (m, 3H), 1.95-2.13 (m, 2H), 2.30 (s, 3H), 2.61 (d, *J* = 6.9 Hz, 2H), 2.65-2.87 (m, 2H), 3.30-3.55 (m, 2H), 3.69 (d, *J* = 12 Hz, 2H), 4.59 (t, *J* = 4.2 Hz, 2H), 6.75-7.02 (m, 6H), 12.61 (bs, 1H); Anal Calcd. for C<sub>21</sub>H<sub>25</sub>ClF<sub>3</sub>NO: C, 63.08; H, 6.30; N, 3.50. Found: C, 62.94; H, 6.34; N, 3.36.

## Example 139

10

4-((5,6,7,8-Tetrahydro-2-naphthyl)methyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine hydrochloride



15

A) 4-((2-Naphthyl)methyl)pyridine was prepared from 2-bromonaphthalene, *n*-BuLi and 4-cyanopyridine in two steps as a yellow solid: mp 66-67 °C, <sup>1</sup>H NMR (CDCl<sub>3</sub>) 4.13 (s, 2H), 7.14 (d, *J* = 6.0 Hz, 2H), 7.27 (dd, *J* = 5.7 and 1.8 Hz, 1H), 7.42-7.52 (m, 2H), 7.64 (s, 1H), 7.74-7.86 (m, 3H), 8.51 (dd, 4.8 and 1.5 Hz, 2H).

B) 4-((5,6,7,8-Tetrahydro-2-naphthyl)methyl)piperidine hydrochloride. A mixture of 4-((2-naphthyl)methyl)pyridine (1.50 g, 6.84 mmol), PtO<sub>2</sub> (100 mg) in MeOH (50 mL) and concd HCl (1 mL) was allowed to shake under H<sub>2</sub> (Parr, 20-30 psig) for 4 days to give the title compound as a colorless, crystalline solid (1.39 g, 76%): mp 213-214 °C; <sup>1</sup>H NMR (D<sub>2</sub>O) 1.30-1.48 (m, 2H), 1.68-1.90 (m, 7H), 2.53 (d, *J* = 6.6 Hz, 2H), 2.64-2.76 (m, 4H), 2.90 (td, *J* = 13 and 2.4 Hz, 2H), 3.31-3.42 (m, 2H), 6.96-7.01 (m, 2H), 7.08 (d, *J* = 8.1 Hz, 1H).

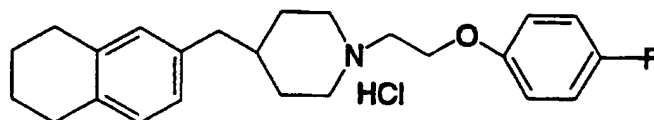
35

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C) The title compound was prepared from 4-((5,6,7,8-tetrahydro-2-naphthyl)methyl) piperidine hydrochloride (250 mg, 940  $\mu\text{mol}$ ), 2-(4-hydroxyphenoxy)ethyl bromide (204 mg, 940  $\mu\text{mol}$ ) and  $\text{NaHCO}_3$  (162 mg, 1.93 mmol) as a pale beige solid (152 mg):  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ ) 1.55-1.65 (m, 2H), 1.70-1.96 (m, 7H), 2.54 (d,  $J = 6.3$  Hz, 2H), 2.62-2.78 (m, 4H), 3.05 (t,  $J = 12$  Hz, 2H), 3.43-3.68 (m, 4H), 4.25 (t,  $J = 4.8$  Hz, 2H), 6.72 (d,  $J = 9.0$  Hz, 2H), 6.80-6.90 (m, 4H), 6.95 (d,  $J = 7.5$  Hz, 1H); Anal. Calcd for  $\text{C}_{24}\text{H}_{32}\text{ClNO}_2 \cdot \text{H}_2\text{O}$ : C, 68.64; H, 8.16; N, 3.33. Found: C, 68.39; H, 7.99; N, 3.36.

## Example 140

15 1-(2-(4-Fluorophenoxy)ethyl)-4-((5,6,7,8-tetrahydro-2-naphthyl)methyl)piperidine hydrochloride



20 The title compound was prepared from 4-((5,6,7,8-tetrahydro-2-naphthyl)methyl) piperidine hydrochloride (250 mg, 940  $\mu\text{mol}$ ), 2-(4-fluorophenoxy)ethyl bromide (216 mg, 987  $\mu\text{mol}$ ) and  $\text{K}_2\text{CO}_3$  (266 mg, 1.93 mmol) as a colorless solid (220 mg): mp 181-183  $^{\circ}\text{C}$ ;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 1.60-2.12 (m, 9H), 2.54 (d,  $J = 7.2$  Hz, 2H), 2.65-2.81 (m, 6H), 3.20-3.55 (m, 2H), 3.59-3.71 (m, 2H), 4.52 (t,  $J = 4.2$  Hz, 2H), 6.77-7.01 (m, 7H), 12.55 (bs, 1H); Anal. Calcd for  $\text{C}_{24}\text{H}_{31}\text{ClFNO}$ : C, 71.36; H, 7.74; N, 3.47. Found: C, 71.30; H, 7.78; N, 3.39.

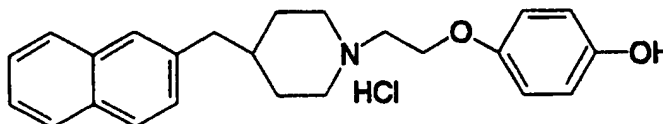


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## Example 141

1 - (2 - (4-Hydroxyphenoxy) ethyl) - 4 - ((2-naphthyl)methyl)piperidine hydrochloride

5



A) 4 - ((2-Naphthyl)methyl)piperidine hydrochloride. A mixture of 4 - ((2-naphthyl) methyl)pyridine (750 mg, 10 3.42 mmol) and  $\text{PtO}_2$  (50 mg) in MeOH (25 mL) containing concd HCl (0.5 mL) was stirred under  $\text{H}_2$  at ambient pressure (balloon) for 19 h to yield the title compound as a pale yellow granular solid (324 mg): mp 215-217 °C;  $^1\text{H}$  NMR ( $\text{D}_2\text{O}$ ) 1.30-1.48 (m, 2H), 1.67-1.98 (m, 3H), 15 2.69 (d,  $J = 6.9$  Hz, 2H), 2.82 (td,  $J = 13$  and 3.0 Hz, 2H), 3.26-3.38 (m, 2H), 7.36 (d,  $J = 8.4$  Hz, 1H), 7.45-7.56 (m, 2H), 7.65 (s, 1H), 7.80-7.92 (m, 3H).

B) The title compound was prepared from 4 - ((2-naphthyl)methyl)piperidine hydrochloride (150 mg, 573 20  $\mu\text{mol}$ ), 2 - (4-hydroxyphenoxy)ethyl bromide (130 mg, 602  $\mu\text{mol}$ ) and  $\text{NaHCO}_3$  (97 mg, 1.17 mmol) as a pale yellow solid (182 mg): mp 221-222 °C;  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ ) 1.53-1.72 (m, 2H), 1.87-2.12 (m, 3H), 2.81 (d,  $J = 6.9$  Hz, 2H), 25 2.92-3.18 (m, 2H), 3.43-3.70 (m, 4H), 4.25 (t,  $J = 4.8$  Hz, 2H), 6.73 (d,  $J = 9.3$  Hz, 2H), 6.85 (d,  $J = 9.3$  Hz, 2H), 7.32-7.49 (m, 3H), 7.66 (s, 1H), 7.76-7.85 (m, 3H); Anal. Calcd for  $\text{C}_{24}\text{H}_{28}\text{ClNO}_2 \cdot 0.4\text{H}_2\text{O}$ : C, 71.15; H, 7.16; N, 3.46. Found: C, 71.17; H, 6.80; N, 3.11.

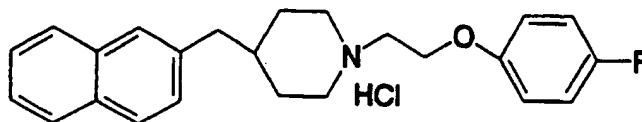
30

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## Example 142

1-(2-(4-Fluorophenoxy)ethyl)-4-((2-naphthyl)methyl)piperidine hydrochloride

5

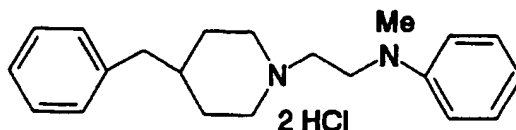


The title compound was prepared from 4-((2-naphthyl)methyl)piperidine hydrochloride (150 mg, 573  $\mu$ mol), 2-(4-fluorophenoxy)ethyl bromide (132 mg, 602  $\mu$ mol) and  $K_2CO_3$  (162 mg, 1.17 mmol) as a colorless solid (126 mg): mp 170-172 °C;  $^1H$  NMR ( $CDCl_3$ ) 1.60-1.92 (m, 3H), 2.02-2.41 (m, 2H), 2.65-2.90 (m, 4H), 3.45-3.55 (m, 2H), 3.60-3.71 (m, 2H), 4.51 (t,  $J$  = 4.2 Hz, 2H), 6.77-7.01 (m, 4H), 7.25 (d,  $J$  = 6.0 Hz, 1H), 7.40-7.51 (m, 2H), 7.57 (s, 1H), 7.72-7.84 (m, 3H) 12.64 (bs, 1H). Anal. Calcd for  $C_{24}H_{27}ClFNO$ : C, 72.08; H, 6.80; N, 3.50. Found: C, 71.73; H, 6.64; N, 3.34.

20

## Example 143

4-Benzyl-1-((2-(*N*-methyl-*N*-phenyl)amino)ethyl)piperidine dihydrochloride



25

A) *N*-(Ethylcarboxy)methyl-*N*-methylaniline. From a mixture of *N*-methylaniline (2.00 g, 18.7 mmol), ethyl bromoacetate (3.12 g, 18.7 mmol) and  $K_2CO_3$  (2.58 g, 18.7 mmol) in  $CH_3CN$  (50 mL) was obtained the title compound as a yellow liquid (2.70 g):  $^1H$  NMR ( $CDCl_3$ ) 1.24 (t,  $J$  = 7.2 Hz, 3H), 3.07 (s, 3H), 4.06 (s, 2H), 4.18 (q,  $J$  = 7.2 Hz, 2H), 6.66-6.79 (m, 3H), 7.20-7.27 (m, 2H).

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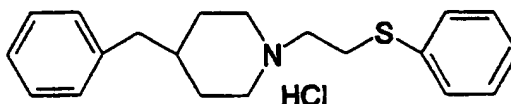
B) 4-Benzyl-1-((2-(*N*-methyl-*N*-phenyl)amino-1-oxo)ethyl)piperidine. A mixture of 4-benzylpiperidine (1.00 g, 5.7 mmol) and ethyl 2-(*N*-(*N*-methylanilino))acetate (500 mg, 2.59 mmol) was stirred at 150 °C under N<sub>2</sub> for 3 days to yield the title compound as a colorless oil (462 mg, 55%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.18 (qd, *J* = 12 and 3.9 Hz, 2H), 1.62-1.85 (m, 3H), 2.45-2.62 (m, 3H), 2.90-3.05 (m, 4H), 3.82 (d, *J* = 13 Hz, 1H), 4.06 (d, *J* = 16 Hz, 1H), 4.13 (d, *J* = 16 Hz, 1H), 4.58 (d, *J* = 13 Hz, 1H), 6.65-6.76 (m, 3H), 7.10-7.33 (m, 7H).

C) 4-Benzyl-1-((2-(*N*-methyl-*N*-phenyl)amino)ethyl)piperidine dihydrochloride. A solution of 4-benzyl-1-((2-(*N*-methyl-*N*-phenyl)amino-1-oxo)ethyl)piperidine (270 mg, 837 μmol) in anhydrous THF (20 mL) with borane-THF complex in THF (~0.1 M, 19 mL, 1.9 mmol) was refluxed under N<sub>2</sub> for 1 h to yield the free base of the title compound as an amber oil (208 mg, 79%). The free base was converted to hydrochloride to yield the title compound as a fluffy colorless solid (97 mg): mp 205-206 °C; <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.62 (q, *J* = 12 Hz, 2H), 1.80-1.96 (m, 3H), 2.60 (d, *J* = 6.3 Hz, 2H), 2.98 (t, *J* = 12 Hz, 2H), 3.26-3.40 (m, 5H), 3.61 (d, *J* = 12 Hz, 2H), 4.10 (t, *J* = 7.2 Hz, 2H), 7.14-7.68 (m, 10H); Anal. Calcd for C<sub>21</sub>H<sub>30</sub>Cl<sub>2</sub>N<sub>2</sub>•0.1H<sub>2</sub>O: C, 65.82; H, 7.94; N, 7.31. Found: C, 65.72; H, 7.88; N, 7.16.

## Example 144

30

4-Benzyl-1-(2-thiophenoxyethyl)piperidine hydrochloride



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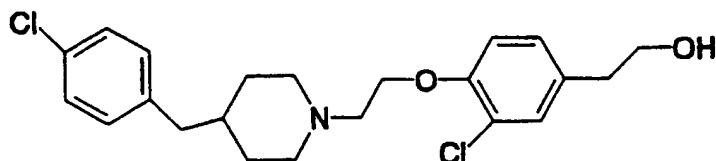
A) 2-Thiophenoxyethyl bromide. A mixture of NaOH (728 mg, 18.2 mmol) in absolute EtOH (40 mL) was stirred for 15 min while the reaction vessel was purged with N<sub>2</sub>. Thiophenol (2.00 g, 1.86 mL, 18.2 mmol, MCB, 5 used as received) was added. The mixture was stirred under N<sub>2</sub> until all the NaOH dissolved. Neat 1,2-dibromoethane (17.1 g, 7.84 mL, 91.0 mmol, Acros) was added in one portion with stirring under N<sub>2</sub>. The reaction was allowed to stir for 3 days under N<sub>2</sub> at 25 10 °C. The solution was added to a dilute NaCl solution (200 mL) and the resulting phases were separated. The aqueous portion was extracted with CHCl<sub>3</sub> (3 x 75 mL). The combined organic portion was washed with ice cold NaOH solution (1 M, 2 x 50 mL) and H<sub>2</sub>O (2 x 100 mL), was 15 filtered through cotton and the solvent was removed to give a brown liquid. The remaining dibromide was removed by vacuum distillation (H<sub>2</sub>O aspirator, 80 °C oil bath) to give a brown liquid. The liquid was distilled (kugelrohr, OT = 90-100 °C, 0.06 Torr) to yield the 20 title compound as a colorless liquid (3.10 g, 78%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.25-3.34 (m, 2H), 3.42-3.51 (m, 2H), 7.22-7.42 (m, 5H).

B) The title compound was prepared from 4- 25 benzyloxyethyl bromide (500 mg, 2.85 mmol), 2-thiophenoxyethyl bromide (651 mg, 3.00 mmol) and K<sub>2</sub>CO<sub>3</sub> (415 mg, 3.00 mmol) as a colorless solid (715 mg): mp 183-184 °C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.60-1.86 (m, 3H), 1.96-2.15 (m, 2H), 2.46-2.66 (m, 4H), 3.00-3.20 (m, 2H), 3.43- 30 3.60 (m, 4H), 7.06-7.46 (m, 10H). Anal. Calcd for C<sub>20</sub>H<sub>26</sub>ClNS: C, 69.04; H, 7.53; N, 4.03. Found: C, 68.99; H, 7.43; N, 4.07.

## Example 145

4-(4-Chlorobenzyl)-1-[2-(2-chloro-4-(2-hydroxyethyl)phenoxy)ethyl] piperidine

5



A) Ethyl 3-chloro-4-(2-bromoethoxy)phenylacetate.

From a mixture of ethyl 3-chloro-4-hydroxyphenylacetate  
10 (6.43 g, 30 mmol), potassium carbonate (6.9 g, 50 mmol)  
and 10.4 mL of 1,2-dibromoethane was obtained 6.5 g  
(67%) of the title product as a white solid. <sup>1</sup>H NMR  
(CDCl<sub>3</sub>) 1.254 (t, J = 7.2 Hz, 3 H), 3.526 (s, 2 H),  
3.659 (t, J = 6.6 Hz, 2 H), 4.161 (q, J = 7.2 Hz, 2 H),  
15 4.325 (t, J = 6.6 Hz, 2 H), 6.872 (d, J = 8.4 Hz, 1 H),  
7.114 (d, J = 8.4 Hz, 1 H), 7.315 (s, 1 H).

B) 1-[2-(2-Chloro-4-

Ethoxycarbonylmethylphenoxy)ethyl]-4-(4-chlorobenzyl)  
20 piperidine. From a mixture of ethyl 3-chloro-4-(2-  
bromoethoxy)phenylacetate (1.93 g, 6.0 mmol), 4-  
chlorobenzylpiperidine hydrochloride (1.50 g, 6.0  
mmol), potassium carbonate (4.14 g, 30 mmol) was  
obtained 2.62 g (100%) of the title compound as a pale  
25 yellow oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.256 (t, J = 6.9 Hz, 3 H),  
1.50 (m, 1 H), 1.584 (m, 4 H), 2.529 (m, 2 H), 2.68 (m,  
2 H), 3.001-3.177 (m, 4 H), 3.525 (s, 2 H), 4.139 (m, 4  
H), 6.873 (d, J = 8.4 Hz, 2 H), 7.084 (d, J = 8.4 Hz, 2  
H), 7.112-7.304 (m, 3H).

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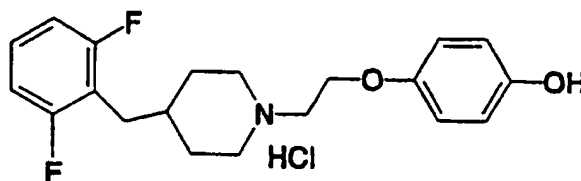
C) The title compound was prepared from reduction of  
1-[2-(2-chloro-4-ethoxycarbonylmethylphenoxy)ethyl]-4-  
(4-chlorobenzyl)piperidine (450.3 mg, 1.0 mmol) by  
LiAlH<sub>4</sub> (38 mg, 1.0 mmol) as oily product (298 mg). <sup>1</sup>H

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NMR (CD<sub>3</sub>OD) 1.248 (m, 2 H), 1.374 (s, 1 H), 1.572 (m, 4 H), 2.530 (m, 2 H), 2.677 (m, 1 H), 2.782 (m, 2 H), 2.991-3.139 (m, 4 H), 3.828 (m, 2 H), 4.131 (m, 2 H), 6.868 (m, 1 H), 7.103 (m, 2 H), 7.233 (m, 4 H). HRMS 5 Calcd for C<sub>22</sub>H<sub>27</sub><sup>35</sup>Cl<sub>2</sub>NO<sub>2</sub>: 407.1435; Found: 407.1427.

## Example 146

10 1-[2-(4-Hydroxyphenoxy)ethyl]-4-(2,6-difluorobenzyl)piperidine hydrochloride



A) 4-(2,6-Difluorobenzyl)piperidine hydrochloride was  
15 prepared from triphenylphosphine and 2,6-difluorobenzyl  
bromide in 4 steps as white solid. mp 2216-218 °C. <sup>1</sup>H  
NMR (CHCl<sub>3</sub>) 1.826 (m, 5 H), 2.679 (s, 2 H), 2.813 (m, 2  
H), 3.455 (d, J = 11.1 Hz, 2 H), 6.861 (m, 2 H), 7.177  
(m, 1 H), 9.40 (s, 1 H), 9.62 (s, 1 H).

20

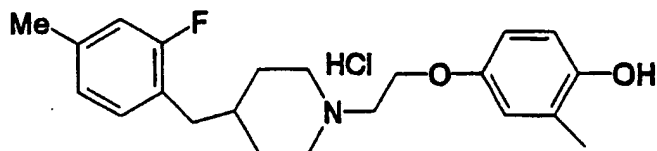
B) The title compound was prepared from 2-(4-  
benzyloxyphenoxy)ethyl bromide (0.393 g, 1.28 mmol), 4-  
(2,6-difluorobenzyl)piperidine hydrochloride (0.317 g,  
1.28 mmol) and potassium carbonate (0.444 g, 3.2 mmol)  
25 in two steps as off white solid (0.240 g). mp 198-200  
°C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.595 (m, 2 H), 1.906 (m, 3 H),  
2.705 (d, J = 5.7 Hz, 2 H), 3.029 (t, J = 12.3 Hz, 2  
H), 3.303 (m, 2 H), 3.629 (d, J = 12.6 Hz, 2 H), 4.238  
(t, J = 4.5 Hz, 2 H), 6.702 (d, J = 9.0 Hz, 2 H), 6.825  
30 (d, J = 9.0 Hz, 2 H), 6.953 (m, 2 H), 7.277 (m, 1 H).

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## Example 147

1- [2- (4-Hydroxy-3-methylphenoxy) ethyl] -4- (2-fluoro-4-methylbenzyl) piperidine hydrochloride

5



A) 4'-Benzyloxy-3'-methylacetophenone. From a mixture of 4'-hydroxy-3'-methylacetophenone (10 g, 66.6 mmol), benzyl bromide (11.4 g, 66.6 mmol), potassium carbonate (13.8 g, 99.9 mmol) was obtained 15.0 g (94%) of the title compound as a white solid. mp 64-66 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.322 (s, 3 H), 2.552 (s, 3 H), 5.164 (s, 2 H), 6.892 (d, J = 9.3 Hz, 1 H), 7.342-7.428 (m, 5 H), 15 7.790 (m, 2 H).

B) 4-Benzyloxy-3-methylphenol. A solution of 4'-benzyloxy-3'-methylacetophenone (6.0 g, 25 mmol) in 100 mL of dichloromethane containing 8.63 g (25.0 mmol) of 20 MCPBA was allowed to stir at rt for 6 days. The mixture was washed with saturated sodium thiosulfate solution and saturated sodium bicarbonate solution. Evaporation of dichloromethane gave a crude ester, which was dissolved into 250 mL of methanol. To this 25 solution was added sodium methoxide (2.70 g, 50 mmol) and then stirred at rt for 1 hr. The methanol was evaporated and 50 mL of 2M HCl aqueous solution was added. The mixture was extracted with dichloromethane (3X50 mL), dried over sodium sulfate. Evaporation of 30 solvent and further purification by flash chromatography gave 5 g (93%) of the phenol as a white solid. mp 69-71 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.246 (s, 3 H), 4.398 (s, 1 H), 5.014 (s, 2 H), 6.604 (m, 1 H), 6.675 (m, 1 H), 6.771 (m, 1 H), 7.315-7.447 (m, 5 H).

35

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C) 2-(4-Benzyloxy-3-methylphenoxy)ethyl bromide.

From a mixture of 4-benzyloxy-3-methylphenol (5.0 g, 0.025 mol), potassium carbonate (8.63 g, 0.625 mol) and 25 mL of 1,2-dibromoethane was obtained 5.0 g (63%) of the title compound as a pale yellow oil, <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.263 (s, 3 H), 3.608 (t, J = 5.7 Hz, 2 H), 4.230 (t, J = 5.7 Hz, 2 H), 5.026 (s, 2 H), 6.655 (m, 1 H), 6.780 (m, 2 H), 7.313-7.443 (m, 5 H).

10 D) 4-Pyridyl-(2-fluoro-4-methylphenyl)methanol. To a slurry of sodium borohydride (189 mg, 5.0 mmol) in 20 mL of ethanol was added a solution of 2-fluoro-4-methylphenyl 4-pyridyl ketone (1.075 g, 5.0 mmol) in 20 mL of ethanol at rt. The mixture was allowed to stir at rt for overnight. The mixture was poured into 200 mL of water and extracted with ethyl acetate (3 x 50 mL). The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation of solvent gave 1.0 g (100%) of the product as a white solid. mp 131-133 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.335 (s, 3 H), 2.858 (s, 1 H), 6.093 (s, 1 H), 6.861-6.967 (m, 2 H), 7.250 (m, 2 H), 7.325 (m, 2 H), 8.529 (m, 2 H).

E) 4-(2-Fluoro-4-methylbenzyl)piperidine

25 hydrochloride. A mixture of 4-pyridyl-(2-fluoro-4-methylphenyl)methanol (1.09 g, 5.0 mmol) and 0.27 g of 30% Pd/C in 50 mL of methanol containing 1.0 mL of conc. HCl was hydrogenated at 55 psi for 3 days to give 1.1 g (90%) of the title compound as white solid. mp 196-198 °C. <sup>1</sup>H NMR (CHCl<sub>3</sub>) 1.292 (m, 2 H), 1.679 (m, 3 H), 2.141 (m, 3 H), 2.443 (d, J = 6.6 Hz, 2 H), 2.753 (m, 2 H), 3.207 (m, 2 H), 6.795 (m, 2 H), 6.970 (m, 1 H).

35 F) The title compound was prepared from 4-(2-fluoro-4-methylbenzyl)piperidine hydrochloride (311.7 mg, 1.28 mmol), 2-(4-benzyloxy-3-methylphenoxy)ethyl bromide



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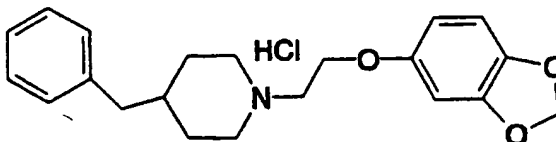
(411 mg, 1.28 mmol) and potassium carbonate (444 mg, 3.2 mmol) in two steps as white-off solid (244 mg), mp 165-167 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.503 (m, 2 H), 1.848 (m, 3 H), 2.076 (s, 3 H), 2.223 (s, 3 H), 2.560 (m, 2 H), 2.932 (m, 2 H), 3.389 (m, 2 H), 3.526 (m, 2 H), 4.141 (t, J = 5.1 Hz, 2 H), 6.758 (s, 1 H), 6.667 (s, 1 H), 6.788-6.858 (m, 3 H), 7.109 (m, 1 H). Anal. Calcd for C<sub>22</sub>H<sub>29</sub>ClFNO<sub>2</sub>: C, 67.08; H, 7.42; N, 3.98. Found: C, 66.85; H, 7.44; N, 3.46.

10

## Example 148

1- [2- (3,4-Methylenedioxyphenoxy)ethyl] -4-benzylpiperidine hydrochloride

15



A) 2- (3,4-Methylenedioxyphenoxy)ethyl bromide. From a mixture of sesamol (4.14 g, 0.03 mol), potassium carbonate (10.35 g, 0.075 mol) and 13 mL of 1,2-dibromoethane was obtained 4.8 g (65%) of the title compound as a white solid. mp 70-72 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.603 (t, J = 6.3 Hz, 2 H), 4.216 (t, J = 6.3 Hz, 2 H), 5.931 (s, 2 H), 6.350 (m, 1 H), 6.517 (m, 1 H), 6.697 (m, 1 H).

25

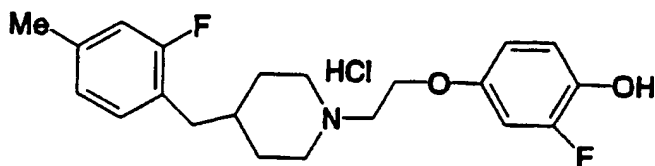
B) The title compound was prepared from 4-benzylpiperidine (1.02 g, 5.8 mmol), 2- (3,4-methylenedioxyphenoxy)ethyl bromide (1.43 g, 5.8 mmol) and potassium carbonate (2.0 g, 14.5 mmol) as a white solid (1.66 g): mp 153-155 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.70 (m, 1 H), 1.86 (m, 2 H), 2.051 (m, 2 H), 2.614 (d, J = 7.2 Hz, 2 H), 2.766 (m, 2 H), 3.344 (s, 2 H), 3.635 (d, J = 12.3 Hz, 2 H), 4.466 (s, 2 H), 5.912 (s, 2 H), 6.312

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(m, 1 H), 6.429 (m, 1 H), 6.674 (d,  $J = 8.4$  Hz, 1 H),  
7.132 (m, 2 H), 7.260 (m, 3 H), 12.5 (brs, 1 H).

## Example 149

5 1-[2-(4-Hydroxy-3-fluorophenoxy)ethyl]-4-(2-fluoro-4-methylbenzyl) piperidine hydrochloride



10 A) 1-Acetyloxy-2-fluorobenzene. A solution of 2-fluorophenol (22.4 g, 0.20 mol) in acetyl chloride (18.8 g, 0.24 mol) was allowed to stir at 80 °C for 5 h. Evaporation of excess acetyl chloride gave 30 g (98%) of the title compound as a colorless oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.405 (s, 3 H), 7.181-7.260 (m, 4 H).

B) 3'-Fluoro-4'-hydroxyacetophenone. A mixture of 1-acetyloxy-2-fluorobenzene (30 g, 0.2 mol) and anhydrous aluminum chloride (33.35 g, 0.25 mol) in 80 mL of  
20 carbon disulfide was refluxed for 24 h until evolution of hydrogen chloride had ceased. The mixture was hydrolyzed by adding 4N HCl aqueous solution (200 mL). A brown solid was filtered off and purified by recrystallization from toluene, giving 20 g (67%) of  
25 the title compound as brown solid. mp 125-127 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.564 (s, 3 H), 6.182 (s, 1 H), 7.070 (m, 1 H), 7.682-7.753 (m, 2 H).

C) 4-Benzyloxy-3-fluorophenol was obtained from 3'-  
30 fluoro-4'-hydroxyacetophenone, benzyl bromide and potassium carbonate in two steps as a white solid: mp 80-82 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 4.616 (s, 1 H), 5.065 (s, 2 H), 6.466 (m, 1 H), 6.629 (dd,  $J_1 = 12.0$  Hz,  $J_2 = 3.0$  Hz, 1 H), 6.860 (m, 1 H), 7.316-7.437 (m, 5 H).

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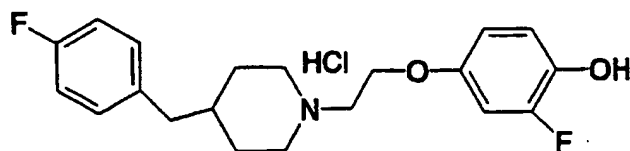
D) 2-(4-Benzoyloxy-3-fluorophenoxy)ethyl bromide was prepared from 4-benzoyloxy-3-fluorophenol (5.45 g, 0.025 mol), potassium carbonate (8.63 g, 0.625 mol) and 25 mL of 1,2-dibromoethane as a pale yellow solid (6.6 g, 81%): mp 63-65 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.606 (t, J = 6.3 Hz, 2 H), 4.218 (t, J = 6.3 Hz, 2 H), 5.082 (s, 2 H), 6.582 (m, 1 H), 6.699 (m, 1 H), 6.914 (m, 1 H), 7.318-7.440 (m, 5 H).

10 E) The title compound was prepared from 4-(2-fluoro-4-methylbenzyl)piperidine hydrochloride (311.7 mg, 1.28 mmol), 2-(4-benzoyloxy-3-fluorophenoxy)ethyl bromide (411 mg, 1.28 mmol), potassium carbonate (444 mg, 3.2 mmol) in two steps as white-off solid (270 mg), mp 128-130 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.40 (m, 2 H), 1.704 (m, 3 H), 2.114 (s, 3 H), 2.422 (d, J = 6.3 Hz, 2 H), 2.837 (m, 2 H), 3.303 (m, 2 H), 3.430 (d, J = 11.4 Hz, 2 H), 4.072 (m, 2 H), 6.50 (m, 1 H), 6.632-6.750 (m, 4 H), 6.90 (m, 1 H). Anal. Calcd for C<sub>21</sub>H<sub>26</sub>ClF<sub>2</sub>NO<sub>2</sub>·0.4H<sub>2</sub>O: C, 62.25; H, 6.67; N, 3.46. Found: C, 62.20; H, 6.61; N, 3.22.

## Example 150

1-[2-(4-Hydroxy-3-fluorophenoxy)ethyl]-4-(4-fluorobenzyl) piperidine hydrochloride

25



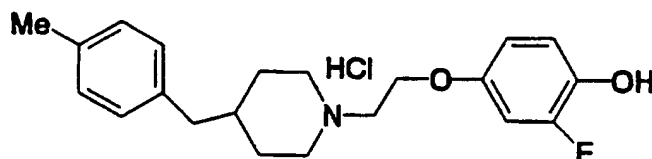
The title compound was prepared from 4-(4-fluorobenzyl)piperidine hydrochloride (344 mg, 1.50 mmol), 2-(4-benzoyloxy-3-fluorophenoxy)ethyl bromide (487 mg, 1.50 mmol), potassium carbonate (518 mg, 3.75 mmol) in two steps as white-off solid (277 mg), mp 184-186 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.40 (m, 2 H), 1.709 (m, 3 H), 2.424 (d, J = 4.8 Hz, 2 H), 2.850 (m, 2 H), 3.319 (m, 2 H),

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3.443 (d,  $J = 12.0$  Hz, 2 H), 4.087 (s, 2 H), 6.50 (m, 1 H), 6.642 (m, 2 H), 6.833 (m, 2 H), 7.021 (m, 2 H).

## Example 151

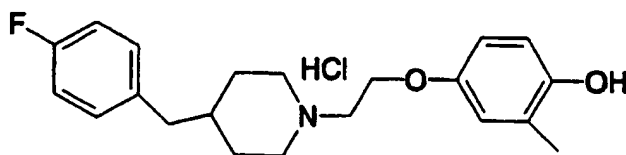
- 5 1-[2-(4-Hydroxy-3-fluorophenoxy)ethyl]-4-(4-methylbenzyl) piperidine hydrochloride



- 10 The title compound was prepared from 4-(4-methylbenzyl)piperidine hydrochloride (347 mg, 1.54 mmol), 2-(4-benzoxo-3-fluorophenoxy)ethyl bromide (499 mg, 1.54 mmol) and potassium carbonate (531 mg, 3.85 mmol) in two steps as white-off solid (272 mg): mp  
 15 148-150 °C.  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ ) 1.38 (m, 2 H), 1.699 (m, 3 H), 2.100 (s, 3 H), 2.375 (d,  $J = 6.3$  Hz, 2 H), 2.834 (m, 2 H), 3.307 (m, 2 H), 3.427 (d,  $J = 11.7$  Hz, 2 H), 4.078 (t,  $J = 4.8$  Hz, 2 H), 6.48 (m, 1 H), 6.638 (m, 2 H), 6.844 (m, 4 H). Anal. Calcd for  $\text{C}_{21}\text{H}_{27}\text{ClFNO}_2 \cdot 0.3\text{H}_2\text{O}$ :  
 20 C, 65.45; H, 7.22; N, 3.64. Found: C, 65.54; H, 7.15; N, 3.60.

## Example 152

- 25 1-[2-(4-Hydroxy-3-methylphenoxy)ethyl]-4-(4-fluorobenzyl) piperidine hydrochloride



- 30 The title compound was prepared from 4-(4-fluorobenzyl)piperidine hydrochloride (344 mg, 1.5 mmol), 2-(4-benzoxo-3-methylphenoxy)ethyl bromide (482

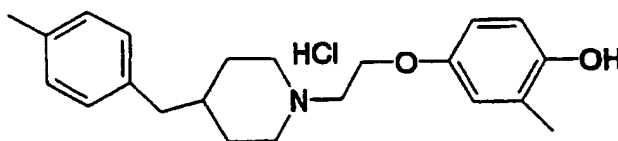
- 183 -

mg, 1.5 mmol) and potassium carbonate (518 mg, 3.8 mmol) in two steps as white-off solid (240 mg): mp 118-120 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.40 (m, 2 H), 1.699 (m, 3 H), 1.975 (s, 3 H), 2.441 (m, 2 H), 2.82 (m, 2 H), 3.310 (m, 2 H), 3.45 (m, 2 H), 4.054 (s, 2 H), 6.481 (s, 2 H), 6.753 (s, 1 H), 6.83 (m, 2 H), 7.021 (m, 2 H). Anal. Calcd for C<sub>21</sub>H<sub>27</sub>ClFNO<sub>2</sub>·0.7H<sub>2</sub>O: C, 64.25; H, 7.29; N, 3.57. Found: C, 64.24; H, 7.02; N, 3.91.

10

## Example 153

1-[2-(4-Hydroxy-3-methylphenoxy)ethyl]-4-(4-methylbenzyl)piperidine hydrochloride



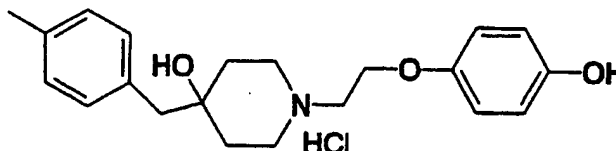
15

The title compound was prepared from 4-(4-methylbenzyl)piperidine hydrochloride (339 mg, 1.5 mmol), 2-(4-benzoxo-3-methylphenoxy)ethyl bromide (482 mg, 1.5 mmol) and potassium carbonate (518 mg, 3.8 mmol) in two steps as white-off solid (250 mg): mp 161-163 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.328 (m, 2 H), 1.697 (m, 3 H), 1.964 (s, 3 H), 2.092 (s, 3 H), 2.384 (m, 2 H), 2.826 (m, 2 H), 3.279 (m, 2 H), 3.427 (m, 2 H), 4.037 (d, J = 4.5 Hz, 2 H), 6.469 (m, 2 H), 6.563 (m, 1 H), 6.877 (m, 4 H). Anal. Calcd for C<sub>22</sub>H<sub>30</sub>ClNO<sub>2</sub>·0.6H<sub>2</sub>O: C, 68.31; H, 8.13; N, 3.62. Found: C, 68.52; H, 7.85; N, 3.65.

## Example 154

1- [2- (4-Hydroxyphenoxy) ethyl] -4-hydroxy-4- (4-methylbenzyl) piperidine hydrochloride

5



A) 1-Benzyl-4-hydroxy-4- (4-methylbenzyl) piperidine.

To a 250-ml three-necked round-bottomed flask was added  
 10 2.31 g of Mg turnings and 15 mL of anhydrous THF under  
 $N_2$ . To which was added dropwise a solution of 1,2-  
 dibromoethane (0.489 g, 2.65 mmol) in 5 mL of THF at  
 rt. After addition, THF was removed and the residue  
 was rinsed with THF (2 x 5 mL). To this residue was  
 15 added dropwise a solution of 4-methylbenzyl chloride  
 (13.0 g, 92.6 mmol) in 50 mL of THF at 0 °C. After  
 addition, the solution was allowed to stir at rt for 2  
 h and another 50 mL of THF was added. After cooling  
 down to -35 °C - -40 °C, a solution of 4-  
 20 benzylpiperidone (5.0 g, 26.5 mmol) in 20 mL of THF was  
 added dropwise. After the addition was complete, the  
 reaction mixture was allowed to stir at rt for 3 h and  
 stand overnight. To this reaction mixture was added  
 100 mL of saturated  $NH_4Cl$  aqueous solution at 0 °C and  
 25 then extracted with dichloromethane (2 x 50 mL). The  
 combined organic phase was evaporated in vacuo to give  
 an oil, which was redissolved into 200 mL of  
 dichloromethane and washed with saturated  $NH_4Cl$  aqueous  
 solution (2 x 30 mL) and brine (50 mL), and then dried  
 30 over sodium sulfate. Evaporation of solvent followed  
 by flash chromatography (EtOAc  $R_f$  = 0.25), giving 7.5 g  
 (96%) of the product as a pale yellow oil.  $^1H$  NMR  
 ( $CDCl_3$ ) 1.476 (m, 2 H), 1.725 (m, 2 H), 2.046 (s, 1 H),  
 2.323 (m, 5 H), 2.611 (m, 2 H), 2.713 (s, 2 H), 3.505  
 35 (s, 2 H), 7.086 (m, 4 H), 7.299 (m, 5 H).

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B) 4-Hydroxy-4-(4-methylbenzyl)piperidine hydrochloride. A mixture of 1-benzyl-4-(4-methylbenzyl)-4-hydroxypiperidine (2.8g, 9.5 mmol) and 700 mg of 10% Pd/C in 100 mL of 95% ethanol was hydrogenated at 50 psi for overnight. The catalyst was removed through a short column of celite (10 g) and washed with methanol (3 x 15 mL). To the filtrate was added 12 mL of 1M HCl in methanol. Evaporation of methanol gave a residue, to which was added 30 mL of ether. The mixture was stirred at rt for 2 days. A white solid was collected by filtration, giving 2.1 g (92%) of the title product. mp 183-185 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.680 (m, 2 H), 2.097 (m, 2 H), 2.338 (s, 3 H), 2.783 (s, 2 H), 3.241 (m, 5 H), 7.049 (d, J = 7.5 Hz, 2 H), 7.142 (d, J = 7.5 Hz, 2 H), 9.30 (brs, 1 H), 9.515 (brs, 1 H).

C) 1-[2-(4-Benzyloxyphenoxy)ethyl]-4-hydroxy-4-(4-methylbenzyl)piperidine hydrochloride. A mixture of 2-(4-benzyloxyphenoxy)ethyl bromide (368 mg, 1.2 mmol), 4-(4-methylbenzyl)-4-hydroxypiperidine hydrochloride (290 mg, 1.2 mmol), potassium carbonate (414 mg, 3 mmol) in 30 mL of acetonitrile was allowed to reflux for 12 h. The inorganic salt was removed through a short column of silica gel and washed with ethyl acetate (3 x 25 mL). The combined filtrate was evaporated in vacuo to give a crude mixture, which was purified by flash chromatography (5% methanol in ethyl acetate), giving a pale yellow oil, which was dissolved into methanol (10 mL), to which was added 4 mL of 1 M HCl in methanol. The resulting solution was allowed to stir at rt for 10 min, and methanol was evaporated in vacuo to give a residue, to which 50 mL of ether was added. The resulting mixture was stirred overnight. A white solid was collected by filtration and dried in vacuo, giving 420 mg (75%) of the title product: mp 179-181 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.605 (s, 2 H), 1.725 (d, J

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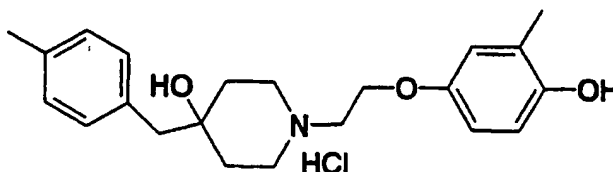
= 14.1 Hz, 2 H), 2.332 (s, 3 H), 2.453 (m, 2 H), 2.809 (s, 2 H), 3.221 (m, 2 H), 3.361 (s, 1 H), 3.464 (d, J = 8.4 Hz, 2 H), 4.488 (s, 2 H), 5.005 (s, 2 H), 6.820 (d, J = 9.0 Hz, 2 H), 6.904 (d, J = 9.0 Hz, 2 H), 7.077 (d, 5 J = 7.5 Hz, 2 H), 7.166 (d, J = 7.5 Hz, 2 H), 7.376 (m, 5 H), 12.4 (bs, 1 H).

D) 1-[2-(4-hydroxyphenoxy)ethyl]-4-hydroxy-4-(4-methylbenzyl)piperidine hydrochloride. To a solution  
10 of 1-[2-(4-benzyloxyphenoxy)ethyl]-4-hydroxy-4-(4-methylbenzyl)piperidine hydrochloride (0.25 g, 0.53 mmol) in 30 mL of methanol was added 62.5 mg of 20% Pd(OH)<sub>2</sub>. The resulting mixture was hydrogenated at 20 psi of hydrogen for 3 h. The catalyst was removed  
15 through a short column of celite (5 g) and washed with methanol (3 x 15 mL). Methanol was evaporated in vacuo to give a residue, to which 50 mL of ether was added. The resulting mixture was stirred overnight. A white solid was collected by filtration and dried in  
20 vacuo, giving 200 mg (100%) of the title product. mp 133-135 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.58 (m, 2 H), 1.75 (m, 2 H), 2.119 (s, 3 H), 2.615 (s, 2 H), 3.20-3.30 (m, 6 H), 4.056 (m, 2 H), 6.528 (d, J = 9.0 Hz, 2 H), 6.645 (d, J = 9.0 Hz, 2 H), 6.938 (s, 4 H).

25

## Example 155

1-[2-(4-hydroxy-3-methylphenoxy)ethyl]-4-hydroxy-4-(4-methylbenzyl)piperidine hydrochloride  
30



The title compound was prepared from 2-(4-benzyloxy-3-methylphenoxy)ethyl bromide (385 mg, 1.2 mmol), 4-(4-



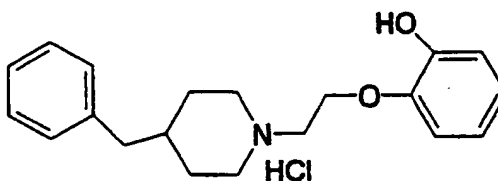
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methybenzyl)-4-hydroxypiperidine hydrochloride (290 mg, 1.2 mmol) and potassium carbonate (414 mg, 3 mmol) in two steps as white solid (200 mg): mp 90-94 °C (dec.). <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.641 (m, 2 H), 1.859 (m, 2 H), 2.083 (s, 3 H), 2.224 (s, 3 H), 2.718 (s, 2 H), 3.260-3.423 (m, 6 H), 4.133 (m, 2 H), 6.585 (s, 2 H), 6.668 (s, 1 H), 7.035 (m, 4 H).

## Example 156

10

4-Benzyl-1-[2-(2-hydroxyphenoxy)ethyl]piperidine hydrochloride



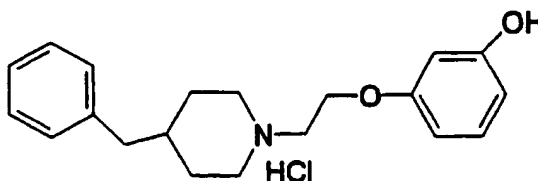
15

The title compound was prepared from 4-benzylpiperidine (228 mg, 1.30 mmol), 2-(2-benzyloxyphenoxy)ethyl bromide (399 mg, 1.3 mmol) and potassium carbonate (449 mg, 3.2 mmol) in two steps as white-off solid (120 mg): mp 220-222 °C (dec.). <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.412 (m, 2 H), 1.726 (d, J = 13.2 Hz, 2 H), 2.453 (d, J = 6.6 Hz, 2 H), 2.868 (m, 2 H), 3.347 (m, 2 H), 3.460 (d, J = 12.3 Hz, 2 H), 4.133 (t, J = 5.4 Hz, 2 H), 6.623-6.695 (m, 3 H), 6.779 (m, 1 H), 6.995-7.123 (m, 5 H).

25

## Example 157

4-Benzyl-1-[2-(3-hydroxyphenoxy)ethyl]piperidine hydrochloride



30

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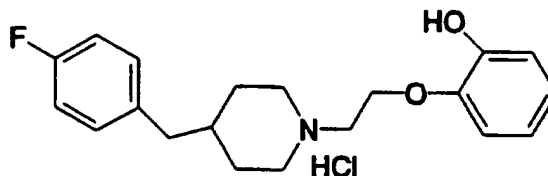
The title compound was prepared from 4-benzylpiperidine (228 mg, 1.30 mmol), 2-(3-benzyloxyphenoxy)ethyl bromide (399 mg, 1.3 mmol) and potassium carbonate (449 mg, 3.2 mmol) in two steps as white-off solid (112 mg): mp 168-170 °C (dec.). <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.40 (m, 2 H), 1.703 (d, J = 12.9 Hz, 2 H), 2.435 (d, J = 6.0 Hz, 2 H), 2.90 (m, 2 H), 3.334 (m, 2 H), 3.406 (m, 2 H), 4.108 (s, 2 H), 6.240-6.292 (m, 3 H), 6.906 (m, 1 H), 6.989-7.096 (m, 5 H).

10

## Example 158

4-(4-Fluorobenzyl)-1-[2-(2-hydroxyphenoxy)ethyl]piperidine hydrochloride

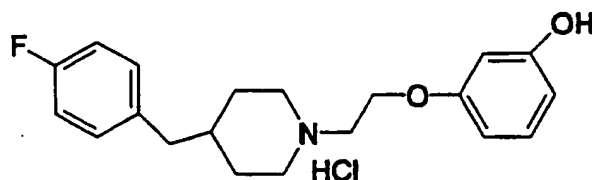
15



The title compound was prepared from 4-(4-fluorobenzyl)piperidine hydrochloride (298 mg, 1.30 mmol), 2-(2-benzyloxyphenoxy)ethyl bromide (399 mg, 1.3 mmol) and potassium carbonate (449 mg, 3.2 mmol) in two steps as white-off solid (240 mg): mp 233-235 °C (dec.). <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.532 (m, 2 H), 1.848 (d, J = 13.2 Hz, 3 H), 2.571 (d, J = 6.3 Hz, 2 H), 3.0 (m, 2 H), 3.483 (m, 2 H), 3.603 (d, J = 10.5 Hz, 2 H), 4.262 (t, J = 5.1 Hz, 2 H), 6.752-6.825 (m, 3 H), 6.909-6.986 (m, 3 H), 7.126-7.173 (m, 2 H).

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Example 159  
4-(4-Fluorobenzyl)-1-[2-(3-Hydroxyphenoxy)ethyl]piperidine hydrochloride

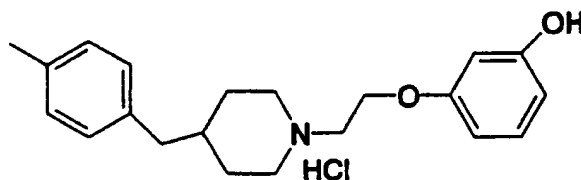


5

The title compound was prepared from 4-(4-fluorobenzyl)piperidine hydrochloride (298 mg, 1.30 mmol), 2-(3-benzyloxyphenoxy)ethyl bromide (399 mg, 1.3 mmol) and potassium carbonate (449 mg, 3.2 mmol) in two steps as white-off solid (250 mg): mp 145-147 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.529 (m, 2 H), 1.821 (d, J = 12.9 Hz, 2 H), 2.551 (d, J = 6.3 Hz, 2 H), 3.003 (m, 2 H), 3.468 (m, 2 H), 3.541 (m, 2 H), 4.243 (t, J = 5.4 Hz, 2 H), 6.369-6.422 (m, 3 H), 6.924-7.034 (m, 3 H), 7.120-7.167 (m, 2 H).

Example 160

20 1-[2-(3-Hydroxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidine hydrochloride



25 The title compound was prepared from 4-(4-methylbenzyl)piperidine hydrochloride (294 mg, 1.30 mmol), 2-(3-benzyloxyphenoxy)ethyl bromide (399 mg, 1.3 mmol) and potassium carbonate (449 mg, 3.2 mmol) in two steps as white-off solid (230 mg): mp 163-165 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.421 (m, 2 H), 1.733 (m, 2 H), 2.135 (s, 3 H), 2.424 (d, J = 5.7 Hz, 2 H), 2.9 (m, 2 H), 3.370 (m,

30

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2 H), 3.448 (m, 2 H), 4.147 (t,  $J = 4.8$  Hz, 2 H), 6.302 (m, 3 H), 6.937 (m, 5 H).

## Example 161

5

1-[2-(2-Hydroxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidine hydrochloride



10

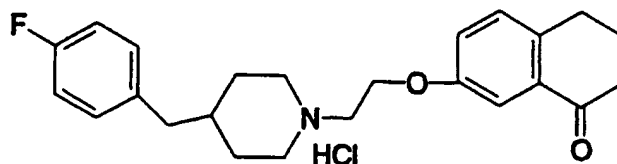
The title compound was prepared from 4-(4-methylbenzyl)piperidine hydrochloride (294 mg, 1.30 mmol), 2-(2-benzyloxyphenoxy)ethyl bromide (399 mg, 1.3 mmol) and potassium carbonate (449 mg, 3.2 mmol) in two steps as white-off solid (240 mg): mp 225-227 °C.  $^1\text{H}$  NMR ( $\text{CD}_3\text{OD}$ ) 1.436 (m, 2 H), 1.758 (d,  $J = 12.9$  Hz, 3 H), 2.135 (s, 3 H), 2.443 (d,  $J = 6.3$  Hz, 2 H), 2.900 (m, 2 H), 3.388 (m, 2 H), 3.503 (m, 2 H), 4.172 (t,  $J = 5.7$  Hz, 2 H), 6.651-6.739 (m, 3 H), 6.818 (m, 1 H), 6.928 (m, 4 H).

20

## Example 162

4-(4-Fluorobenzyl)-1-[2-(1,2,3,4-tetrahydro-1-oxo-naphth-7-oxy)ethyl]piperidine hydrochloride

25



A) 7-(2-Bromoethoxy)-1-tetralone. From 7-hydroxy-1-tetralone (0.175 g, 1.08 mmol), 1,2-dibromoethane (0.50 mL, 5.80 mmol) and anhyd  $\text{K}_2\text{CO}_3$  (0.802 g, 5.80 mmol) in acetone (7.0 mL) was obtained 0.165 g (57%) of the

30

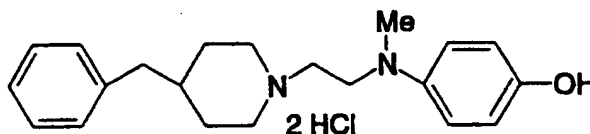
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title compound as yellow oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 2.12 (p, 2H, *J* = 6.0 Hz), 2.64 (t, 2H, *J* = 6.0 Hz), 2.91 (t, 2H, *J* = 6.0 Hz), 3.65 (t, 2H, *J* = 6.0 Hz), 4.33 (t, 2H, *J* = 6.0 Hz), 7.09 (d of d, 1H, *J*<sub>1</sub> = 3.0 Hz, *J*<sub>2</sub> = 8.4 Hz), 5 7.19 (d, 1H, *J* = 8.4 Hz), 7.50 (d, 1H, *J* = 3.0 Hz).

B) From 7-(2-bromoethoxy)-1-tetralone (0.136 g, 0.505 mmol), 4-fluorobenzylpiperidine hydrochloride (0.116 g, 0.505 mmol) and anhyd K<sub>2</sub>CO<sub>3</sub> (0.175 g, 1.27 mmol) in 10 acetonitrile (10 mL) was obtained the title compound as yellow flakes; mp 216 - 18 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.54-1.59 (m, 2H), 1.89-1.94 (m, 3H), 2.11 (p, 2H, *J* = 6.0 Hz), 2.61-2.66 (m, 4H), 2.94 (d, 2H, *J* = 6.0 Hz), 3.06 (br t, 2H, *J* = 12.0 Hz), 3.57-3.68 (m, 4H), 4.39 (t, 2H, *J* 15 = 6.0 Hz), 6.99-7.05 (m, 2H), 7.19-7.23 (m, 3H), 7.31 (d, 1H, *J* = 8.4 Hz), 7.54 (d, 1H, *J* = 3.0 Hz).

## Example 163

20 4-Benzyl-1-(2-(*N*-methyl-4-hydroxyanilino)ethyl)piperidine dihydrochloride



25 A) Ethyl 2-(*N*-(4-hydroxyphenyl)*N*-methyl)aminoacetate. From a mixture of 4-methylaminophenol sulfate (5.00 g, 14.5 mmol), ethyl bromoacetate (4.84 g, 29.0 mmol) and NaHCO<sub>3</sub> (4.87 g, 58.0 mmol) in CH<sub>3</sub>CN (100 mL) was obtained the title compound as an amber oil (5.70 g, 30 94%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.23 (t, *J* = 7.2 Hz, 3 H), 2.99 (s, 3 H), 3.99 (s, 2 H), 4.16 (q, *J* = 7.2 Hz, 2 H), 5.48 (bs, 1 H), 6.59 (d, *J* = 9.0 Hz, 2 H), 6.70 (d, *J* = 8.4 Hz, 2 H).

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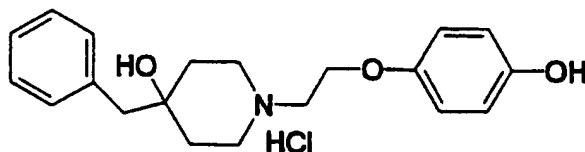
B) The title compound was prepared from 4-benzylpiperidine (1.99 g, 11.4 mmol) and ethyl 2-(*N*-(4-hydroxyphenyl)*N*-methyl)aminoacetate (1.00 g, 4.78 mmol) in two steps as a beige solid: mp 190-192 °C (dec); <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.55-1.72 (q, *J* = 13 Hz, 2 H), 1.82-1.95 (m, 3 H), 2.60 (d, *J* = 6.6 Hz, 2 H), 2.92-3.08 (m, 2 H), 3.24-3.38 (m, 5 H), 3.58 (d, *J* = 12 Hz, 2 H), 4.06 (t, *J* = 7.2 Hz, 2 H), 6.96 (d, *J* = 9.0 Hz, 2 H), 7.14-7.31 (m, 5 H), 7.56 (d, *J* = 9.0 Hz, 2 H).

10

## Example 164

4-Benzyl-4-hydroxy-1-[2-(4-hydroxyphenoxy)ethyl]piperidine hydrochloride

15



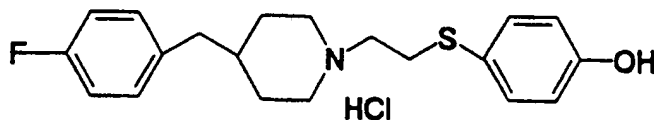
The title compound was prepared from 4-benzyl-4-hydroxypiperidine (383 mg, 2.00 mmol), 2-(4-benzoxypyenoxy)ethyl bromide (614 mg, 2.00 mmol) and potassium carbonate (490 mg, 5.0mmol) in two steps as white-off solid (240 mg): mp 155-156 °C. <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.567 (m, 2 H), 1.782 (m, 3 H), 2.665 (s, 2 H), 3.332 (m, 4 H), 4.075 (s, 2 H), 6.535 (m, 2 H), 6.654 (m, 2 H), 7.079 (m, 5 H).

25

## Example 165

4-(4-Fluorobenzyl)-1-(2-(4-hydroxythiophenoxy)ethyl)piperidine hydrochloride

30



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A) 4-Hydroxythiophenoxyacetaldehyde diethyl acetal.  
From a mixture of NaOH (1.58 g, 39.6 mmol) in absolute EtOH (100 mL) with 4-hydroxythiophenol (5.00 g, 39.6 mmol) and Bromoacetaldehyde diethyl acetal (9.80 g, 5.00 mmol) was obtained the title compound as a very pale yellow liquid (6.80 g, 71%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 1.19 (t, J = 7.2 Hz, 3H), 3.02 (d, J = 5.7 Hz, 2H), 3.48-3.72 (m, 4H), 4.61 (t, J = 5.7 Hz, 1H), 6.06 (bs, 1H), 6.74 (d, J = 8.7 Hz, 2H), 7.30 (d, J = 9.0 Hz, 2 H).

10

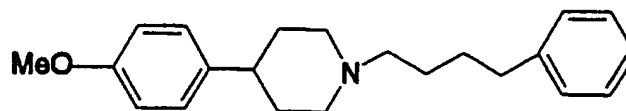
B) 4-Hydroxythiophenoxyacetaldehyde. A stirred solution of 4-hydroxythiophenoxy acetaldehyde diethyl acetal (1.00 g, 4.12 mmol) in EtOH (20 mL) was heated to reflux. Water (50 mL) was added to the solution so as to maintain reflux. Conc'd HCl (1 mL) was added to the refluxing solution and reflux was maintained for 10 min. The reaction was diluted with ice water (100 mL) and was extracted with CHCl<sub>3</sub> (3 x 50 mL). The extract was washed with saturated NaCl solution (100 mL), was 20 filtered (cotton) and the solvent was removed. The residue was dried in vacuo (rt, 0.005 Torr) to yield the title compound as a pale beige solid (570 mg, 82%): <sup>1</sup>H NMR (CDCl<sub>3</sub>) 3.47 (d, J = 3.6 Hz, 2H), 5.84 (s, 1 H), 6.69 (d, J = 8.7 Hz, 2H), 7.27 (d, J = 9.0 Hz, 2H), 25 9.50 (t, J = 3.6 Hz, 1H).

C) The title compound was prepared from 4-(4-fluorobenzyl)piperidine (from 804 mg of the hydrochloride), 4-hydroxythiophenoxyacetaldehyde (560 30 mg, 3.33 mmol) and NaCNH<sub>3</sub>B (416 mg, 6.66 mmol) in MeOH (100 mL) as a colorless crystalline solid (430 mg): mp 177-178 °C; <sup>1</sup>H NMR (CD<sub>3</sub>OD) 1.40-1.60 (m, 2H), 1.76-1.92 (m, 3H), 2.59 (d, J = 6.3 Hz, 2H), 2.81-3.00 (m, 2H), 3.08-3.26 (m, 4H), 3.42-3.58 (m, 2H), 6.78 (d, J = 8.7 35 Hz, 2H), 6.96-7.22 (m, 4 H), 7.36 (d, J = 8.7 Hz, 2H).

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## Example 166

## 4-(4-Methoxyphenyl)-1-(4-phenylbutyl)piperidine



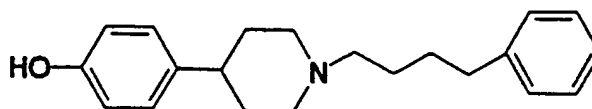
5

The title compound was prepared from 4-(4-methoxyphenyl)piperidine hydrochloride (1.00 g, 4.39 mmol), 4-phenyl-1-tosylbutane (1.40 g, 4.61 mmol) and  $K_2CO_3$  (1.24 g, 9.00 mmol) in  $CH_3CN$  (25 mL) as a beige solid (979 mg, 69%): mp 48-50 °C;  $^1H$  NMR ( $CDCl_3$ ) 1.52-1.86 (m, 8H), 2.01 (td,  $J = 11$  and 3.6 Hz, 2H), 2.34-2.50 (m, 3H), 2.65 (t,  $J = 7.2$  Hz, 2H), 2.98-3.08 (m, 2H), 3.79 (s, 3H), 6.85 (d,  $J = 8.7$  Hz, 2H), 7.12-7.32 (m, 7H).

## Example 167

## 4-(4-Hydroxyphenyl)-1-(4-phenylbutyl)piperidine

20



The title compound was prepared from  $BBr_3$  in  $CH_2Cl_2$  (1 M, 3.75 mL) and 4-(4-methoxyphenyl)-1-(4-phenylbutyl)piperidine (323 mg, 1.00 mmol) in dry  $CH_2Cl_2$  (20 mL) as a colorless crystalline solid (85 mg, 26%): mp 210-211 °C,  $^1H$  NMR ( $CD_3OD$ ) 1.66-2.12 (m, 8H), 2.66-2.87 (m, 3H), 3.00-3.20 (m, 4H), 3.54-3.66 (m, 2H), 6.75 (d,  $J = 8.4$  Hz, 2H), 7.08 (d,  $J = 8.4$  Hz, 2H), 7.14-7.32 (m, 5H).

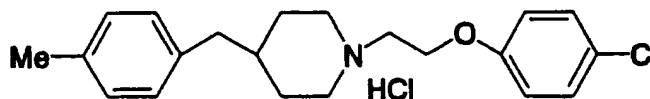


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## Example 168

1-(2-(4-Chlorophenoxy)ethyl)-4-(4-methylbenzyl)piperidine hydrochloride

5

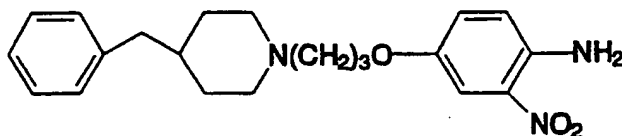


The title compound was prepared from 4-(4-methylbenzyl)piperidine hydrochloride (600 mg, 2.66 mmol), 2-(4-chlorophenoxy)ethyl bromide (658 mg, 2.79 mmol) and  $K_2CO_3$  (754 mg, 5.45 mmol) in  $CH_3CN$  (50 mL) as colorless flakes (661 mg): mp 201-203 °C;  $^1H$  NMR ( $CDCl_3$ ) 1.60-2.12 (m, 5H), 2.31 (s, 3H), 2.58 (d,  $J$  = 7.2 Hz, 2H), 2.63-2.82 (m, 2H), 3.20-3.50 (m, 2H), 3.58-3.70 (m, 2H), 4.53 (t,  $J$  = 4.2 Hz, 2H), 6.80 (d,  $J$  = 9.3 Hz, 2H), 7.00 (d,  $J$  = 7.5 Hz, 2H), 7.09 (d,  $J$  = 7.8 Hz, 2H), 7.24 (d,  $J$  = 8.7 Hz, 2H), 12.60 (b, 1H).

20

## Example 169

1-[3-(4-Amino-3-nitrophenoxy)propyl]-4-benzylpiperidine



25 a) From a mixture of 4-amino-3-nitrophenol (3.08 g, 20.0 mmol),  $K_2CO_3$  (5.52 g, 40.0 mmol), 1-chloro-3-iodopropane (12.24 g, 60.0 mmol) and 18-Crown-6 (20 mg) in THF (60 mL) was obtained 2.34 g (51%) of 3-(4-Amino-3-nitrophenoxy)propyl chloride as short red needles, mp 61-2 °C.  $^1H$  NMR ( $CDCl_3$ ): 2.20-2.28 (m, 2H), 3.743 (t, 2H,  $J$  6), 4.097 (t, 2H,  $J$ =6), 5.892 (bs, 2H,  $NH_2$ ), 6.769 (t, 1H,  $J$ =9), 7.067 (dd, 1H,  $J$ =9; 3), 7.587 (d, 1H,  $J$ =3).

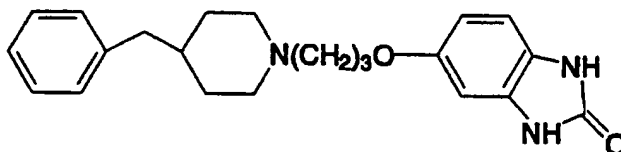
b) From a mixture of 4-benzylpiperidine (715 mg, 4.08 mmol), 3-(4-amino-3-nitrophenoxy)propyl chloride (462 mg, 2.0 mmol) and NaI (360 mg) in toluene (20 mL) was obtained 528 mg (71%) of the title compound as a yellow powder, mp 108-9 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.53-1.60 (m, 2H), 1.84-1.93 (m, 3H), 2.18-2.21 (m, 2H), 2.657 (d, 2H, J=7), 3.16-3.22 (m, 2H), 3.64-3.68 (m, 2H), 4.044 (t, 2H, J=6), 6.778 (d, 1H, J=9), 7.053 (dd, 1H, J=9; 3), 7.13-7.33 (m, 5H), 7.522 (d, 1H, J=3).

10

### Example 170

4-Benzyl-1-[3-(2-oxobenzimidazol-5-  
oxy)propyl]piperidine

15



a) From a mixture of 1-[3-(4-Amino-3-nitrophenoxy)propyl]-4-benzylpiperidine (226 mg, 0.61 mmol) and stannous dihydrate (690 mg, 3.06 mmol) in EtOH (25 mL) was obtained 140 mg (67.6%) of 4-benzyl-1-[(3,4-diamino-phenoxy)propyl]piperidine as a yellowish viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.24-1.37 (m, 2H), 1.46-1.58 (m, 1H), 1.58-1.70 (m, 2H), 1.81-1.97 (m, 4H), 2.458 (t, 2H, J=7.5), 2.536 (d, 2H, J=7), 2.90-2.93 (m, 2H), 3.063 (bs, 2H, NH<sub>2</sub>), 3.503 (bs, 2H, NH<sub>2</sub>), 3.904 (t, 2H, J=6.5), 6.250 (dd, 1H, J=8; 2.5), 6.319 (d, 1H, J=2.5), 6.619 (d, 1H, J=8), 7.13-7.30 (m, 5H).

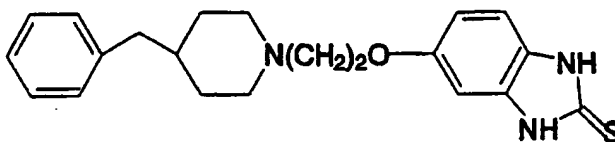
30 b) From a mixture of 4-benzyl-1-[(3,4-diaminophenoxy)propyl]piperidine (140 mg, 0.41 mmol) and CDI (130 mg, 0.8 mmol) in toluene (15 mL) was obtained 89 mg (59%) of the title compound as a white powder. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.14-1.22 (m, 2H), 1.43-1.51 (m, 3H), 1.75-1.82 (m, 4H), 2.531 (d, 2H, J=7), 2.80-

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2.83 (m, 2H), 3.893 (t, 2H, J=7), 6.490 (bs, 2H), 6.771 (d, 1H, J=9), 7.13-7.29 (m, 5H), 10.353 (s, 1H), 10.476 (s, 1H). The hydrochloride, mp. 220-2 °C. Analysis, Calcd. for (C<sub>22</sub>H<sub>28</sub>ClN<sub>3</sub>O<sub>2</sub> + 0.3 HCl): C 64.00, H 6.91, N 10.18; Found: C 64.09, H 6.92, N 9.92.

## Example 171

10 4-Benzyl-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine



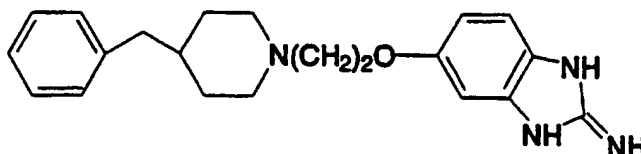
A mixture of 4-benzyl-1-[(3,4-  
15 diaminophenoxy)ethyl]piperidine (326 mg, 1.0 mmol), KOH (66 mg, 1.1 mmol) and CS<sub>2</sub> (66 µL, 1.1 mmol) in 95% EtOH (1.5 mL) and H<sub>2</sub>O (0.2 mL) was refluxed for 3 h, then evaporated, and the residue was purified by chromatography over silica gel (CHCl<sub>3</sub>-MeOH, 4:1) to give  
20 250 mg (68%) of the title compound as a foam solid. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.40-1.48 (m, 2H), 1.54-1.61 (m, 1H), 1.67-1.71 (m, 2H), 2.09-2.18 (m, 2H), 2.517 (d, 2H, J=6), 2.841 (t, 2H, J=5), 3.17-3.20 (m, 2H), 4.139 (t, 2H, J=5), 6.551 (d, 1H, J=2), 6.605 (dd, 1H, J=8.5; 2),  
25 6.950 (d, 1H, J=8.5), 7.11-7.28 (m, 5H). The hydrochloride, mp. 273-5 °C. Analysis, Calcd. for C<sub>21</sub>H<sub>26</sub>ClN<sub>3</sub>OS: C 62.44, H 6.49, N 10.40; Found: C 62.28, H 6.42, N 10.21.

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## Example 172

4-Benzyl-1-(2-(2-iminobenzimidazol-5-oxy)ethyl)piperidine

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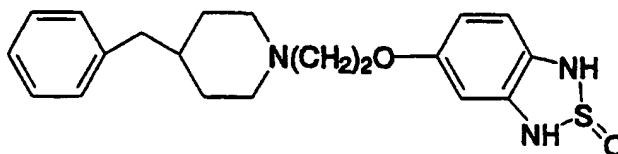


To a solution of 4-benzyl-1-[(3,4-diaminophenoxy)ethyl]piperidine (202 mg, 0.62 mmol) in  
 10 MeOH (1.5 mL) was added 130  $\mu$ L of 5.0 M solution of  
 cyanogen bromide in acetonitrile. The resulting  
 mixture was stirred at r.t. under  $N_2$  for 24 h, then  
 evaporated, and the residue was purified by  
 chromatography over silica gel ( $CHCl_3$ -MeOH, 4:1) to  
 15 give 174 mg (80%) of the title compound as a viscous  
 oil.  $^1H$  NMR ( $CDCl_3$ ): 1.35-1.46 (m, 2H), 1.50-1.67 (m,  
 3H), 2.04-2.12 (m, 2H), 2.539 (d, 2H,  $J=7$ ), 2.773 (t,  
 2H,  $J=6$ ), 3.00-3.03 (m, 2H), 3.50 (bs, 1H), 4.035 (t,  
 2H,  $J=6$ ), 6.243 (dd, 1H,  $J=8$ ; 3), 6.317 (d, 1H,  $J=3$ ),  
 20 6.614 (d, 1H,  $J=8$ ), 7.12-7.30 (m, 5H).

## Example 173

4-Benzyl-1-(2-(2-oxo-2,1,3-benzothiadiazol-5-oxy)ethyl)piperidine

25



a) From a mixture of 2-(4-amino-3-nitrophenoxy)ethyl  
 30 bromide (1.30 g, 5.0 mmol) and stannouschloride  
 dihydrate (5.65 g, 25 mmol) in 95% EtOH (35 mL) was  
 obtained 960 mg (83%) of 2-(3,4-diaminophenoxy)ethyl

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bromide as a pale powder.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 3.597 (t, 2H,  $J=6$ ), 4.210 (t, 2H,  $J=6$ ), 6.273 (dd, 1H,  $J=8$ ; 3), 6.359 (d, 1H,  $J=3$ ), 6.637 (d, 1H,  $J=8$ ).

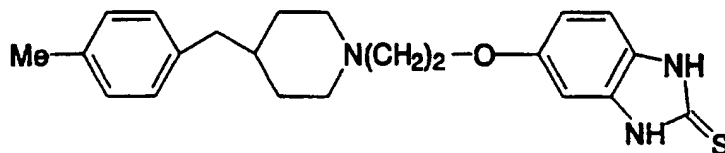
5 b) To a cooled (ice-water) solution of 2-(3,4-diaminophenoxy)ethyl bromide (2.03 g, 8.8 mmol) in pyridine (40 mL) was added dropwise 0.65 mL (8.9 mmol) of  $\text{SOCl}_2$  with stirring. The resulting mixture was stirred at r.t for 2 h, then 4N  $\text{H}_2\text{SO}_4$  was added dropwise  
10 with cooling. The acidic (pH 5) mixture was extracted with  $\text{CHCl}_3$  (4x50 mL). The  $\text{CHCl}_3$  solution was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ), then evaporated to give 420 mg (17%) of 5-(2-bromoethoxy)-2,1,3-benzothiadiazol-2-one  
15 as an orange-yellow powder.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 3.737 (t, 2H,  $J=6$ ), 4.407 (t, 2H,  $J=6$ ), 7.195 (d, 1H,  $J=2$ ), 7.341 (dd, 1H,  $J=9$ ; 2), 7.874 (d, 1H,  $J=9$ ).

c) From a mixture of 4-benzylpiperidine (800 mg, 4.56 mmol), 5-(2-bromoethoxy)-2,1,3-benzothiadiazol-2-one  
20 (420 mg, 1.5 mmol) and  $\text{K}_2\text{CO}_3$  (200 mg, 1.45 mmol) in toluene (35 mL) was obtained 420 mg (78%) of the title compound as a dark brown oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.35-1.43 (m, 2H), 1.52-1.60 (m, 1H), 1.65-1.69 (m, 2H), 2.05-2.13 (m, 2H), 2.552 (d, 2H,  $J=7$ ), 2.867 (t, 2H,  $J=6$ ),  
25 2.99-3.03 (m, 2H), 4.197 (t, 2H,  $J=6$ ), 7.13-7.21 (m, 4H), 7.26-7.32 (m, 3H), 7.824 (d, 1H,  $J=9$ ). The hydrochloride, mp. 225-6  $^\circ\text{C}$ .

## Example 174

30

4-(4-Methylbenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine

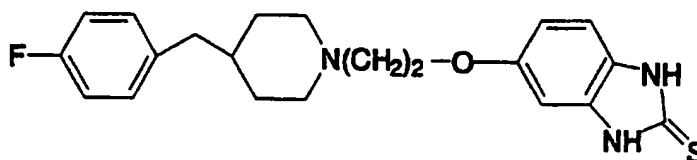


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The title compound was prepared from 4-(4-methylbenzyl)piperidine hydrochloride (451 mg, 2.0 mmol), (4-amino-3-nitro-phenoxy)ethyl bromide (522 mg, 2.0 mmol) and  $K_2CO_3$  (300 mg) in three steps as a pale powder.  $^1H$  NMR ( $CDCl_3$ ): 1.36-1.70 (m, 5H), 2.08-2.15 (m, 2H), 2.038 (s, 3H), 2.488 (d, 2H,  $J=7$ ), 2.839 (t, 2H,  $J=5$ ), 3.09-3.12 (m, 2H), 4.127 (t, 2H,  $J=5$ ), 6.64-6.72 (m, 2H), 6.99-7.09 (m, 5H). The hydrochloride, mp. 271-3 °C. Analysis, Calcd. for  $C_{22}H_{28}ClN_3OS$ : C 63.22, H 6.75, N 10.05; Found: C 62.92, H 6.68, N 9.97.

## Example 175

15 4-(4-Fluorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine



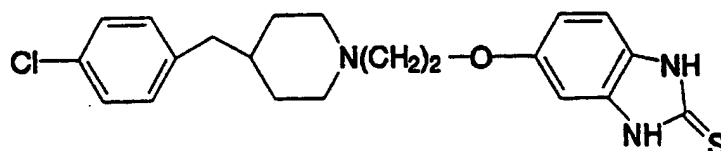
The title compound was prepared from (4-amino-3-nitrophenoxy)ethylbromide (960 mg, 3.68 mmol), 4-(4-fluorobenzyl)piperidine (860 mg, 4.46 mmol) and  $K_2CO_3$  (1.46 g) in three steps as a foam solid.  $^1H$  NMR ( $CDCl_3$ ): 1.39-1.56 (m, 3H), 1.65-1.70 (m, 2H), 2.13-2.20 (m, 2H), 2.508 (d, 2H,  $J=6.5$ ), 2.890 (t, 2H,  $J=5$ ), 3.16-3.20 (m, 2H), 4.61 (t, 2H,  $J=5$ ), 6.633 (bs, 1H), 6.698 (d, 1H,  $J=8.5$ ), 6.92-7.10 (m, 5H). The hydrochloride, mp. 278-80 °C.

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## Example 176

4-(4-Chlorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine

5

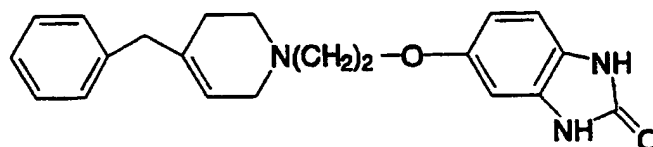


From a mixture of 1-[2-(3,4-diaminophenoxy)ethyl]-4-(4-chlorobenzyl)piperidine (1.30 g, 3.67 mmol), KOH (240 mg, 4.28 mmol) and CS<sub>2</sub> (250  $\mu$ L, 4.16 mmol) in EtOH (5 mL) and water (0.8 mL) was obtained 1.28 g (88%) of the title compound as a foam solid. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.38-1.68 (m, 5H), 2.09-2.17 (m, 2H), 2.481 (d, 2H, J=6.5), 2.851 (t, 2H, J=4.5), 3.18-3.21 (m, 2H), 4.142 (t, 2H, J=4.5), 6.561 (bs, 1H), 6.596 (d, 1H, J=8.5), 6.936 (d, 1H, J=8.5), 7.036 (d, 2H, J=8), 7.029 (d, 2H, J=8). <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 12.360 (s, 1H), 12.402 (s, 1H). The hydrochloride, mp. 291-3 °C. Analysis, Calcd. for C<sub>21</sub>H<sub>25</sub>ClN<sub>3</sub>OS: C 57.53, H 5.75, N 9.58; Found: C 57.82, H 5.65, N 9.44.

## Example 177

4-Benzyl-1-(2-(2-oxobenzimidazol-5-oxy)ethyl)-1,2,5,6-tetrahydropyridine

25



The title compound was prepared from (4-amino-3-nitrophenoxy)ethyl bromide (1.31 g, 5.0 mmol), 4-benzyl-1,2,5,6-tetrahydropyridine (870 mg, 5.02 mmol), K<sub>2</sub>CO<sub>3</sub> (700 g) and KI (80 mg) in three steps as a

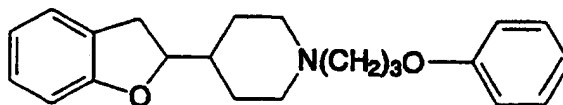
- 202 -

slightly grey powder, mp. 202-3 °C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.952 (bs, 2H), 2.50-2.56 (m, 4H), 2.686 (t, 2H, J=6), 2.973 (bs, 2H), 3.241 (s, 2H), 3.988 (t, 2H, J=6), 5.381 (s, 1H), 6.48- 6.50 (m, 2H), 6.768 (d, 1H, J=9), 5 7.14-7.30 (m, 5H). The hydrochloride, mp. 256-7 °C. Analysis, Calcd. for (C<sub>21</sub>H<sub>24</sub>ClN<sub>3</sub>O<sub>2</sub> + 0.2 HCl): C 64.44, H 6.12, N 10.61; Found: C 64.15, H 6.20, N 10.68.

## Example 178

10

4-(2,3-Dihydrobenzofuran-2-yl)-1-(3-phenoxypropyl)piperidine



15

From a mixture of 4-[2-(2,3-dihydrobenzofuran-2-yl)]piperidine hydrochloride (194 mg, 0.81 mmol), 3-phenoxypropyl chloride (476 mg, 2.22 mmol), NaI (80 mg) and K<sub>2</sub>CO<sub>3</sub> (138 mg) in toluene (15 mL) was obtained 60 mg 20 (71%) of the title compound as a pale solid, <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.87-2.29 (m, 10H), 2.63-2.68 (m, 2H), 2.80-2.87 (m, 1H), 3.08-3.12 (m, 2H), 4.050 (t, 2H, J=6), 6.410 (s, 1H), 6.90-7.51 (m, 9H). The hydrochloride, mp 221-3 °C. Analysis, Calcd. for (C<sub>22</sub>H<sub>28</sub>ClNO<sub>2</sub> + 0.35 25 HCl): C 68.75, H 7.39, N 3.62; Found: C 68.33, H 6.96, N 3.37.

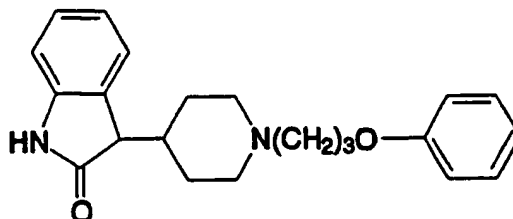


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## Example 179

4-(2-Oxo-2,3-dihydroindol-3-yl)-1-(3-  
phenoxypropyl)piperidine

5

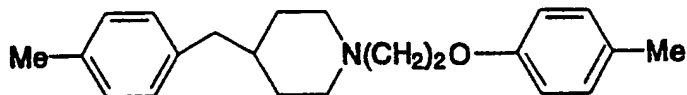


From a mixture of 4-[2-oxo-2,3-dihydroindol-3-yl]piperidine hydrochloride (198 mg, 0.73 mmol), 3-  
10 phenoxy-propyl chloride (476 mg, 2.22 mmol) and  $K_2CO_3$  (138 mg) in toluene (15 mL) was obtained 170 mg (70%)  
of the title compound as a yellow oil,  $^1H$  NMR ( $CDCl_3$ ):  
1.42-1.50 (m, 2H), 1.79-2.03 (m, 6H), 2.10-2.15 (m,  
1H), 2.47-2.52 (m, 2H), 2.90-3.04 (m, 2H), 3.408 (d,  
15 1H,  $J=3.5$ ), 7.001 (t, 1H,  $J=7.5$ ), 7.022 (t, 1H,  $J=7.5$ ),  
7.23-7.29 (m, 3H), 7.909 (s, 1H). The hydrochloride ,  
mp 182-3 °C.

## Example 180

20

4-(4-Methylbenzyl)-1-(2-(4-  
methylphenoxy)ethyl)piperidine



25

From a mixture of 4-(4-methylbenzyl)piperidine (1.14 g,  
6.02 mmol), 2-(4-methylphenoxy)ethyl bromide (630 mg,  
3.01 mmol) and KI (90 mg) in toluene (20 mL) was  
obtained 800 mg (85%) of the title compound as a yellow  
30 oil,  $^1H$  NMR ( $CDCl_3$ ): 1.26-1.38 (m, 2H), 1.45-1.53 (m,  
1H), 1.61-1.66 (m, 2H), 1.99-2.07 (m, 2H), 2.277 (s,  
3H), 2.317 (s, 3H), 2.494 (d, 2H,  $J=7$ ), 2.761 (t, 2H,

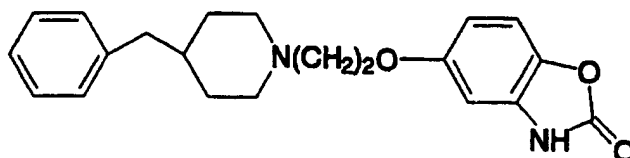
- 204 -

J=6), 2.95-2.99 (m, 2H), 4.067 (t, 2H, J=6), 6.792 (d, 2H, J=8), (d, 2H, J=8), 7.01-7.10 (m, 6H). The hydrochloride, mp 170-1 °C.

5

## Example 181

4-Benzyl-1-(2-(2-oxobenzoxazol-5-oxy)ethyl)piperidine



10

a) From a solution of 4-benzyloxy-3-nitrophenyl acetate (10.48 g, 42.7 mmol) in 70 mL of 20% solution of KOH in MeOH-H<sub>2</sub>O (7:3) was obtained 8.50 g (95%) of 4-benzyloxy-3-nitrophenol as a yellow powder, mp. 137-8 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 5.044 (s, 1H), 5.187 (s, 2H), 7.018 (s, 2H), 7.33-7.46 (m, 6H).

b) From a mixture of 4-benzyloxy-3-nitrophenol (4.91 g, 20 mmol), KOH (1.39 g, 21.0 mmol) in EtOH (50 mL) and 1,2-dibromoethane (11.3 g, 60.0 mmol) was obtained 2.75 g (37%) of 2-(4-benzyloxy-3-nitrophenoxy)ethyl bromide as a solid, mp. 53-4 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 3.639 (t, 2H, J=6), 4.291 (t, 2H, J=6), 5.200 (s, 2H), 7.08-7.10 (m, 2H), 7.40-7.44 (m, 6H).

25

c) From a mixture of 4-benzylpiperidine (2.68 g, 15.1 mmol), 2-(4-benzyloxy-3-nitrophenoxy)ethyl bromide (2.65 g, 7.52 mmol) and KI (110 mg) in toluene (25 mL) was obtained 2.59 g (77%) of 4-benzyl-1-(2-(4-benzyloxy-3-nitrophenoxy)ethyl)piperidine as an orange-yellow oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.30-1.42 (m, 2H), 1.50-1.60 (m, 1H), 1.64-1.68 (m, 2H), 2.02-2.10 (m, 2H), 2.547 (d, 2H, J=7), 2.777 (t, 2H, J=6), 2.95-3.00 (m,

30

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2H), 4.085 (t, 2H, J=6), 5.181 (s, 2H), 7.02-7.46 (m, 8H).

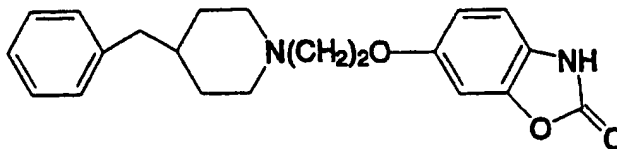
d) A mixture of 4-benzyl-1-(2-(4-benzyloxy-3-nitrophenoxy)ethyl)piperidine (1.40 g, 3.1 mmol) and 10% pd/C (about 500 mg) in MeOH (30 mL) was hydrogenated to give 1.0 g (98%) of 1-(2-(3-amino-4-hydroxyphenoxy)ethyl)-4-benzylpiperidine as a viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.40-1.68 (m, 5H), 2.06-2.13 (m, 2H), 2.530 (t, 2H, J=5.5), 6.000 (d, 2H, J=8), 6.242 (bs, 1H), 6.534 (d, 1H, J=8), 7.12-7.19 (m, 5H).

e) A mixture of 1-(3-amino-4-hydroxyphenoxy)ethyl-4-benzylpiperidine (1.0g, 3.06 mmol) and CDI (650mg, 4.0 mmol) in toluene (25 mL) was refluxed for 20 h, then evaporated. The residue was purified by chromatography over silica gel (CHCl<sub>3</sub>-MeOH, 85:15) to give 600 mg (56%) of the title compound as a slightly pink colored powder, mp. 176-7 °C. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.14-1.23 (m, 2H), 1.40-1.54 (m, 3H), 1.91-1.98 (m, 2H), 2.47-2.50 (m, 3H), 2.620 (t, 2H, J=6), 2.86-2.90 (m, 2H), 4.010 (t, 2H, J=6), 6.603 (dd, 1H, J=9; 2), 6.654 (d, 1H, J=2), 7.13-7.29 (m, 6H). The hydrochloride, mp. 256-8 °C. Analysis, Calcd. for C<sub>21</sub>H<sub>25</sub>ClNO<sub>3</sub>: C 64.86, H 6.48, N 7.20; Found: C 64.73, H 6.51, N 7.04.

25

## Example 182

4-Benzyl-1-(2-(2-oxobenzoxazol-6-oxo)ethyl)piperidine



30

a) From a mixture of 4-nitroresorcinol (1.55 g, 10 mmol) and 85% KOH (720 mg, 12.8 mmol) in EtOH (25 mL) and 1,2-dibromoethane (3.8 g, 20.2 mmol) was obtained

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570 mg (23%) of 2-(3-hydroxy-4-nitrophenoxy)ethyl bromide as a yellow powder, mp. 108-9 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 3.669 (t, 2H, J=6), 4.363 (t, 2H, J=6), 6.54-6.57 (s, 2H), 8.069 (d, 1H, J=9), 10.010 (s, 1H).

5

b) From a mixture of 4-benzylpiperidine (820 mg, 4.68 mmol), 2-(3-hydroxy-4-nitrophenoxy)ethyl bromide (556 g, 2.26 mmol) and KI (180 mg) in toluene (25 mL) was obtained 750 g (97%) of 4-benzyl-1-(2-(3-hydroxy-4-nitrophenoxy)ethyl)piperidine as a yellow powder, mp. 136-7 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.28-1.40 (m, 2H), 1.50-1.68 (m, 1H), 2.02-2.10 (m, 2H), 2.545 (d, 2H, J=7), 2.792 (t, 2H, J=6), 2.93-2.97 (m, 2H), 4.151 (t, 2H, J=6), 6.50-6.53 (m, 2H), 7.13-7.31 (m, 5H), 8.027 (d, 1H, J=10).

c) A mixture of 4-benzyl-1-(3-hydroxy-4-nitrophenoxy)ethylpiperidine (740 mg, 2.17 mmol) and 5% pd/C (100 mg) in MeOH (20 mL) was hydrogenated to give 621 mg (98%) of 1-(2-(4-amino-3-hydroxyphenoxy)ethyl)-4-benzylpiperidine as a viscous oil.

d) From a mixture of 1-(2-(4-amino-3-hydroxyphenoxy)ethyl)-4-benzylpiperidine (620 mg, 2.0 mmol) and CDI (440 mg, 2.7 mmol) in toluene (25 mL) was obtained 590 mg (65%) of the title compound as a grey colored powder. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>): 1.20-1.42 (m, 2H), 1.50-1.58 (m, 1H), 1.64-1.68 (m, 2H), 2.02-2.10 (m, 2H), 2.543 (d, 2H, J=7), 2.784 (t, 2H, J=6), 2.98-3.02 (m, 2H), 4.072 (t, 2H, J=6), 6.669 (dd, 1H, J=9; 2), 6.809 (d, 1H, J=2), 6.888 (d, 1H, J=9), 7.13-7.30 (m, 5H). The hydrochloride, mp. 205-6 °C. Analysis, Calcd. for C<sub>21</sub>H<sub>25</sub>ClNO<sub>3</sub>: C 64.86, H 6.48, N 7.20; Found: C 65.14, H 6.40, N 6.96.

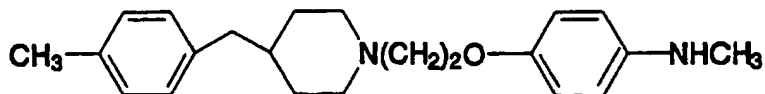
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## Example 183

4-(-4-Methylbenzyl)-1-(2-(4-methylaminophenoxy)ethyl)piperidine

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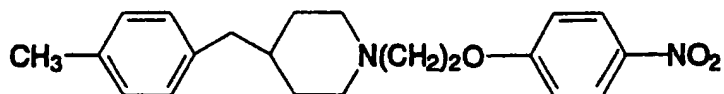


From a mixture of 4-(4-methylbenzyl)piperidine (1.42 mg, 7.5 mmol), 2-(4-methylphenoxy)ethyl bromide (860 mg, 3.74 mmol),  $K_2CO_3$  (260 mg) and KI (180 mg) in toluene (25 mL) was obtained 720 g (57%) of the title compound as a yellow powder, mp. 136-7 °C.  $^1H$  NMR ( $CDCl_3$ ): 1.24-1.36 (m, 2H), 1.50-1.52 (m, 1H), 1.65-1.70 (m, 2H), 1.95-2.05 (m, 2H), 2.319 (s, 3H), 2.499 (d, 15 2H,  $J=7$ ), 6.334 (bs, 1H), 6.59-6.62 (m, 2H), 6.70-6.74 (m, 2H), 7.054 (m, 4H,  $J=7$ ).

## Example 184

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4-(-4-Methylbenzyl)-1-(2-(4-nitrophenoxy)ethyl)piperidine



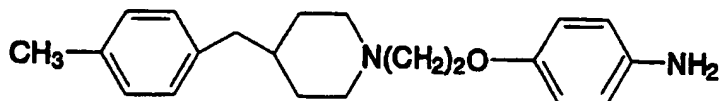
25 From a mixture of 4-(4-methylbenzyl)piperidine (2.27 g, 12.0 mmol), 2-(4-nitrophenoxy)ethyl bromide (1.42 g, 6.0 mmol),  $K_2CO_3$  (130 mg) and KI (120 mg) in toluene (25 mL) was obtained 2.02 g (100%) of the title compound as a viscous oil.  $^1H$  NMR ( $CDCl_3$ ): 1.25-1.38 (m, 2H), 1.46-1.56 (m, 1H), 1.63-1.67 (m, 2H), 2.01-2.09 (m, 2H), 2.314 (s, 3H), 2.498 (d, 2H,  $J=7$ ), 2.797 (t, 2H,  $J=6$ ), 2.94-2.98 (m, 2H), 4.171 (t, 2H,  $J=6$ ), 6.950 (d, 2H,  $J=9$ ), 7.059 (AB, 4H,  $J=8$ ), 8.191 (d, 2H,  $J=9$ ). The hydrochloride, mp. 180-1 °C.

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## Example 185

1-[2-(4-Aminophenoxy)ethyl]-4-(4-methylbenzyl)piperidine

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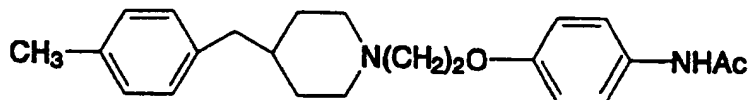


From a mixture of 4-(4-methylbenzyl)-1-[2-(4-nitrophenoxy)ethyl]piperidine (1.80 g, 5.2 mmol),  
10 stannous chloride dihydrate (7.40 g, 32.8 mmol) in EtOH (50 mL) was obtained 1.43 g (84%) of the title compound as a viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.25-1.38 (m, 2H), 1.36-1.56 (m, 1H), 1.61-1.65 (m, 2H), 1.98-2.05 (m, 2H), 2.315 (s, 3H), 2.490 (d, 2H, J=7), 2.726 (t, 2H, J=6), 2.94-2.98 (m, 2H), 3.316 (bs, 2H), 4.015 (t, 2H, J=6), 6.681 (AB, 2H, J=9), 7.056 (AB, 4H, J=9).

## Example 186

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1-[2-(4-Acetamidophenoxy)ethyl]-4-(4-methylbenzyl)piperidine



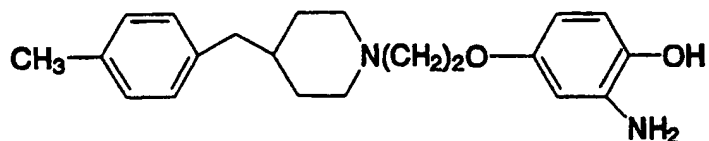
25 From a solution of 1-[2-(4-aminophenoxy)ethyl]-4-(4-methylbenzyl)piperidine (1.22 g, 3.72 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (20 mL) with acetic anhydride (2 mL) at r.t. was obtained 1.27 g (85%) of the title compound as a white powder. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.25-1.38 (m, 2H), 1.42-1.55 (m, 1H), 1.62-1.66 (m, 2H), 2.00-2.07 (m, 2H), 2.152 (s, 3H), 2.315 (s, 3H), 2.493 (d, 2H, J=7), 2.754 (t, 2H, J=6), 2.94-2.98 (m, 2H), 4.065 (t, 2H, J=6), 6.847 (d, 2H, J=9), 7.055 (AB, 4H, J=9), 7.363 (d, 2H, J=9).

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## Example 187

1- (2- (3-Amino-4-hydroxyphenoxy)ethyl) -4- (4-methylbenzyl)piperidine

5



a) From a mixture of 4- (4-methylbenzyl)piperidine (1.96 g, 30.36 mmol), 2- (4-benzyloxy-3-nitrophenoxy)ethyl bromide (1.825 g, 5.18 mmol) and KI (100 mg) in toluene (50 mL) was obtained 1.965 g (80%) of 4- (4-methylbenzyl)-1- (2- (4-benzyloxy-3-nitrophenoxy)ethyl)piperidine as yellow solid, mp. 176-7 °C. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.25-1.39 (m, 2H), 1.46-1.54 (m, 1H), 1.60-1.66 (m, 2H), 2.00-2.07 (m, 2H), 2.320 (s, 3H), 2.500 (d, 2H, J=9), 2.754 (t, 2H, J=6), 2.93-2.97 (m, 2H), 4.068 (t, 2H, J=6), 5.179 (s, 2H), 7.02-7.10 (m, 4H), 7.33-7.46 (m, 3H).

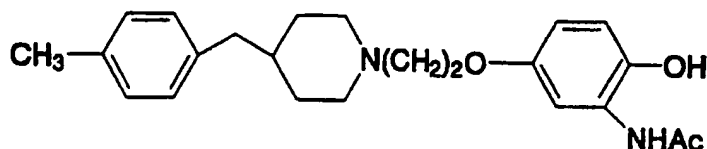
b) A mixture of 4-benzyl-1- (4-benzyloxy-3-nitrophenoxy)ethylpiperidine (1.46 g, 3.17 mmol) and 10% pd/C (200 mg) in MeOH (25 mL) was hydrogenated to give 1.0 g (92%) of 1- (2- (3-amino-4-hydroxyphenoxy)ethyl) -4- (4-methylbenzyl)piperidine as a viscous oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>): 1.32-1.45 (m, 2H), 1.49-1.55 (m, 1H), 1.63-1.67 (m, 2H), 2.03-2.11 (m, 2H), 2.319 (s, 3H), 2.491 (t, 2H, J=7), 2.724 (t, 2H, J=6), 3.02-3.06 (m, 2H), 3.942 (t, 2H, J=6), 5.997 (dd, 1H, J=8.5; 2), 6.245 (d, 1H, J=2), 6.536 (d, 1H, J=8.5), 7.056 (AB, 4H, J=8).

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## Example 188

1- (3-Acetamido-4-hydroxyphenoxy) ethyl-4- (4-methylbenzyl) piperidine

5

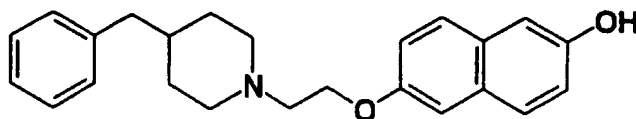


From a solution of 1- (2- (3-amino-4-hydroxyphenoxy) ethyl) -4- (4-methylbenzyl) piperidine (950 mg, 2.8 mmol) in  $\text{CH}_2\text{Cl}_2$  (20 mL) with acetic anhydride (2 mL) was obtained 930 mg (87%) of 1- (2- (3-acetamido-4-hydroxyphenoxy) ethyl) -4- (4-methylbenzyl) piperidine as a viscous oil.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ): 1.30-1.42 (m, 2H), 1.48-1.56 (m, 1H), 1.64-1.68 (m, 2H), 2.02-2.09 (m, 2H), 2.246 (s, 3H), 2.320 (s, 3H), 2.500 (d, 2H,  $J=7$ ), 2.731 (t, 2H,  $J=6$ ), 2.99-3.03 (m, 2H), 3.956 (t, 2H,  $J=6$ ), 6.530 (dd, 1H,  $J=9$ ; 3), 6.76-6.79 (m, 2H), 7.027 (d, 2H,  $J=8$ ), 7.090 (d, 2H,  $J=8$ ), 7.830 (bs, 1H).

20

## Example 189

4-Benzyl-1- (2- (2-hydroxynaphth-6-oxy) ethyl) piperidine



25

a) From a mixture of 2-benzyloxy-6-hydroxynaphthalene (0.50 g, 2.00 mmol), 1- (4-benzyl-piperidin-1-yl) -2-bromo-ethanone (0.60 g, 2.02 mmol) and potassium carbonate (0.55 g, 3.98 mmol) in tetrahydrofuran (40 mL) were obtained 0.76 g (75%) of 2- (6-benzyloxy-naphthalen-2-yloxy) -1- (4-benzyl-piperidin-1-yl) -ethanone.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 7.64 (2H, dd,  $J=8.6$ , 6.5), 7.48 (2H, d,  $J=7.23$ ), 7.42-7.38 (2H, m), 7.35-7.11

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(10H, m), 5.16 (2H, s), 4.75 (2H, s), 4.56 (1H, d, J=13), 4.02 (1H, d, J=13.7), 3.08 (1H, td, J=13.7, 2.4), 2.56 (1H, td, J=12.8, 2.9), 2.53 (2H, d, J=7.2) 1.8-1.68 (3H, m), 1.26-1.12 (2H, m).

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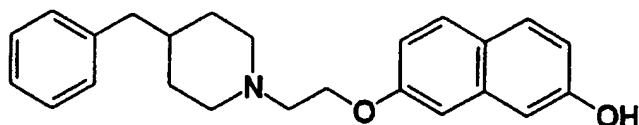
b) To 2-(6-benzyloxy-naphthalen-2-yloxy)-1-(4-benzyl-piperidin-1-yl)-ethanone (0.71 g, 1.53 mmol) in anhydrous tetrahydrofuran (25 ml) was added  $\text{BH}_3 \cdot \text{SMe}_2$  (0.62 ml, 6.20 mmol) and diisopropyl amine (0.214 ml, 1.53 mmol), and the solution was refluxed for 18 h under  $\text{N}_2$ . The reaction was cooled in an ice bath and quenched with dropwise addition of methanol (15 ml). The solvent was evaporated, the solid washed with hexanes and evaporated. The solid was washed with hexanes, filtered, and air dried to give 0.69 g (100%) of 4-benzyl-1-[2-(6-benzyloxy-naphthalen-2-yloxy)-ethyl]-piperidine.  $^1\text{H}$  NMR ( $\text{CDCl}_3$ ) 7.64-7.56 (2H, m), 7.45 (2H, d, J=7.3), 7.39-7.003 (12H, m), 5.12 (2H, d, J=3.6), 4.55 (1H, t, J=5.4), 4.51 (1H, t, J=5.4), 3.62 (1H, t, J=5.4), 3.18-3.14 (3H, m), 2.92 (1H, m), 2.60-2.54 (3H, m), 2.15-2.0 (1H, m), 1.66-1.51 (4H, m).

c) A mixture of 4-benzyl-1-[2-(6-benzyloxy-naphthalen-2-yloxy)-ethyl]-piperidine (0.67 g, 1.48 mmol) and 20% palladium on carbon (0.06 g) in methanol (8 ml) and tetrahydrofuran (8 ml) was shaken on a Parr hydrogenation apparatus under a hydrogen atmosphere (50 psi) for 20 h. After removal of the catalyst, the filtrate was evaporated and the white solid (0.51 g, 95%) was dissolved in tetrahydrofuran (5 ml). A solution of isethionic acid in methanol (4.6 ml, 1.28 mmol) was added, and the solid precipitate was filtered off. The solid was washed with tetrahydrofuran, and dried in vacuo overnight to give the title compound (0.51 g, 82%), mp 139-141 °C. Analysis calculated for  $\text{C}_{24}\text{H}_{27}\text{NO}_2 \cdot \text{C}_7\text{H}_6\text{O}_4\text{S}$ : C, 64.04; H, 6.82; N, 2.87; S, 6.58. Found: C, 63.88; H, 6.77; N, 2.70; S, 6.60.

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## Example 190

4-Benzyl-1-(2-(3-hydroxynaphth-6-oxy)ethyl)piperidine



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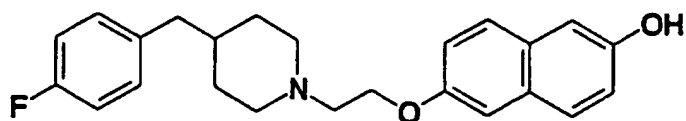
The title compound was prepared from 7-benzyloxy-naphthalen-2-ol (1.00 g, 4.00 mmol), 1-(4-benzyl-piperidin-1-yl)-2-bromo-ethanone (1.20 g, 4.05 mmol) and potassium carbonate (1.10 g, 7.96 mmol) in tetrahydrofuran (40 ml) in three steps as a solid, mp 159-160 °C. Analysis calculated for  $C_{24}H_{27}NO_2 \cdot 0.16H_2O$ : C, 79.11; H, 7.56; N, 3.85. Found: C, 79.11; H, 7.63; N, 3.83.

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## Example 191

4-(4-Fluorobenzyl)-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine

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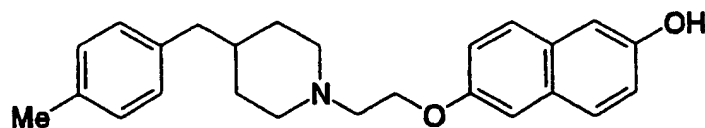
a) From a suspension of 6-benzyloxy-naphthalen-2-ol (1.00 g, 4.00 mmol), 1,2-dibromoethane (1.72 ml, 20.00 mmol), and potassium carbonate (1.10 g, 7.96 mmol) in acetonitrile (25 ml) was obtained 2-benzyloxy-6-(2-bromo-ethoxy)-naphthalene (0.64 g, 45%) as a white solid.  $^1H$  NMR ( $CDCl_3$ ) 7.61 (2H, d,  $J=8.79$ ), 7.45 (d, 2H,  $J=7.32$ ), 7.37 (2H, t,  $J=7.25$ ), 7.32-7.29 (1H, m), 7.20-7.15 (2H, m), 7.11 (1H, dd,  $J=8.79$ , 2.44), 7.06 (1H, d,  $J=2.44$ ), 5.12 (2H, s), 4.35 (2H, t,  $J=6.22$ ), 3.66 (2H, t,  $J=6.35$ )

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b) The title compound was prepared from 4-(4-Fluorobenzyl)-piperidine and 2-benzyloxy-6-(2-bromo-ethoxy)-naphthalene and potassium carbonate in two steps as a solid, mp 184-185 °C. Analysis calculated for  $C_{24}H_{26}FNO_2$ : 5 C, 75.96; H, 6.91; N, 3.69; F, 5.01. Found: C, 75.52; H, 6.86; N, 3.50; F, 5.15.

## Example 192

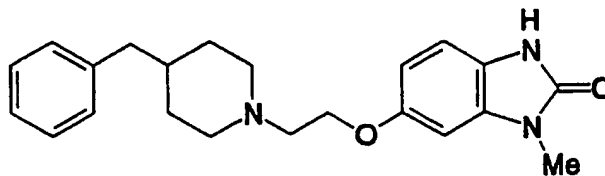
10 4-(4-Methylbenzyl)-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine



15 The title compound was prepared from 4-(4-Methylbenzyl)-piperidine and 2-benzyloxy-6-(2-bromoethoxy)-naphthalene and potassium carbonate in two steps as a solid, mp 164-166 °C. Analysis calculated for  $C_{25}H_{29}NO_2$ : C, 79.96; H, 7.78; N, 3.73. Found: C, 79.63; H, 7.84; N, 3.67.

## Example 193

25 4-Benzyl-1-(2-(3-methyl-2-oxobenzamidazol-5-oxy)ethyl)piperidine



a) To a solution of methyl 5-hydroxy-2-nitro-benzoate  
30 (7.97 g, 40.43 mmol), triphenylphosphine (12.73 g,  
48.53 mmol), and 2-benzyloxyethanol (5.86 ml, 41.24  
mmol) in tetrahydrofuran (100 ml) was added DEAD (8.04

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ml, 95%, 48.51 mmol) dropwise. After addition of the DEAD, the reaction was stirred under nitrogen for 18 h. The solvent was evaporated, benzene was added, and the triphenylphosphine oxide was filtered off. The solid  
5 was washed with some benzene, and the filtrate evaporated. The yellow oil was dissolved in minimal benzene, and chromatographed on silica gel eluting with 25% ethyl acetate/hexanes to give methyl 5-(2-benzyloxy-ethoxy)-2-nitro-benzoate (12.47 g, 93%) as a  
10 light yellow oil. Analysis calculated for  $C_{17}H_{17}NO_6$ : C, 61.63; H, 5.17; N, 4.23. Found: C, 61.46; H, 5.02; N, 4.28.

b) To a solution of methyl 5-(2-benzyloxy-ethoxy)-2-nitro-benzoate (8.26 g, 24.93 mmol) in methanol (200  
15 ml) was added LiOH (1N, 80 ml), and the reaction mixture was heated to 50 °C for 2 h. The solvent was evaporated, water was added (100 ml), and the solution was cooled in an ice bath. 3N HCl was added slowly to  
20 pH = 2.5. The aqueous layer was salted with NaCl and extracted with ethyl acetate (4 x 75 ml). The aqueous layer was reacidified and extracted with ethyl acetate (100 ml). The combined organic extracts were washed with brine (100 ml), dried over  $MgSO_4$ , filtered and  
25 evaporated to give an oil that solidified upon standing. The solid was washed with ether (30 ml), filtered and air dried to give 5-(2-benzyloxy-ethoxy)-2-nitro-benzoic acid (5.99 g, 75%).  $^1H$  NMR ( $CDCl_3$ ) 7.96 (1H, d,  $J=9.0$ ), 7.36-7.25 (5H, m), 7.17 (1H, d,  $J=2.7$ ),  
30 7.05 (1H, dd,  $J=9.0, 2.7$ ), 4.62 (2H, s), 4.22 (2H, m), 3.84 (2H, m).

c) To a solution of 5-(2-benzyloxy-ethoxy)-2-nitro-benzoic acid (5.98 g, 18.85 mmol) in benzene (100 ml)  
35 and anhydrous tetrahydrofuran (25 ml) was added triethylamine (3.07 ml, 22 mmol) followed by diphenylphosphoryl azide (4.74 ml, 22 mmol). The reaction was stirred at

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room temp for 15 min, and then refluxed under nitrogen for 4 h. Methanol (3 ml, 74.06 mmol) was added, and the reaction was refluxed for 18 h. The solvent was evaporated, and the oil chromatographed on silica gel  
5 eluting with 25% ethyl acetate/hexanes to give [5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-carbamic acid methyl ester (6.12 g, 94%) as an oil. Analysis calculated for  $C_{17}H_{18}N_2O_6$ : C, 58.96; H, 5.24; N, 8.09. Found: C, 58.94; H, 5.11; N, 7.87

10

d) To a solution of [5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-carbamic acid methyl ester (2.03 g, 5.86 mmol) in anhydrous dimethylformamide (20 ml) was added iodomethane (1.82 ml, 29.3 mmol), followed by portion  
15 wise addition of NaH (0.35 g, 60%, 8.79 mmol). The reaction was stirred under nitrogen for 2 h. The reaction was quenched with  $NH_4Cl$  (sat) (10 ml) and brine (10 ml), and the aqueous layer was extracted with ether (3 x 30 ml). The combined organics were dried over  
20  $MgSO_4$ , filtered and evaporated. The residue was chromatographed on silica gel eluting with hexanes, then 30% ethyl acetate/hexanes to give [5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-methyl-carbamic acid methyl ester (0.93 g, 89%) as an oil. Analysis calculated for  
25  $C_{18}H_{20}N_2O_6$ : C, 59.99; H, 5.59; N, 7.77. Found: C, 59.30; H, 5.34; N, 7.62.

e) To a solution of [5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-methyl-carbamic acid methyl ester (0.93 g, 2.58  
30 mmol) in methanol (50 ml) and tetrahydrofuran (50 ml) was added Raney Ni and the mixture was stirred under a hydrogen atmosphere (1 atm) until all starting material was consumed as indicated by TLC. The catalyst was filtered, washed generously with  
35 tetrahydrofuran, and the filtrate evaporated. The residue was washed with anhydrous tetrahydrofuran and evaporated (2 x 15 ml). The oil was dissolved in

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anhydrous tetrahydrofuran (30 ml) and NaH was added (0.31 g, 60%, 7.75 mmol), and the reaction mixture was heated to reflux under nitrogen for 3.5 h. The reaction was quenched with  $\text{NH}_4\text{Cl}$  (sat) (20 ml), water (20 ml) and ethyl acetate (20 ml). The layers were separated, and the aqueous layer was extracted with ethyl acetate (2x25 ml). The combined organics were washed with brine (25 ml), dried over  $\text{MgSO}_4$ , filtered, and evaporated to give 6-(2-benzyloxy-ethoxy)-1-methyl-1,3-dihydro-benzoimidazol-2-one (0.75 g, 97%) as a solid. Analysis calculated for  $\text{C}_{17}\text{H}_{18}\text{N}_2\text{O}_3$ : C, 68.44; H, 6.08; N, 9.39. Found: C, 68.64; H, 6.13; N, 8.96.

f) A mixture of 6-(2-benzyloxy-ethoxy)-1-methyl-1,3-dihydro-benzoimidazol-2-one (0.69 g, 2.31 mmol) and 20% palladium on carbon (0.10 g) in methanol (10 ml) and tetrahydrofuran (10 ml) was stirred under a hydrogen atmosphere (1 atm) for 2 h. After removal of the catalyst, the catalyst was washed with boiling methanol (50 ml). The filtrate was evaporated to give 6-(2-hydroxy-ethoxy)-1-methyl-1,3-dihydro-benzoimidazol-2-one (0.46 g, 96%) as a solid.  $^1\text{H}$  NMR (DMSO) 10.54 (1H, s), 6.78 (1H, d,  $J=8.3$ ), 6.70 (1H, d,  $J=2.2$ ), 6.50 (1H, dd,  $J=8.3, 2.4$ ), 4.79 (1H, t,  $J=5.6$ ), 3.90 (2H, t,  $J=5.0$ ), 3.64 (2H, q,  $J=5.2$ ), 3.18 (3H, s).

g) To a solution of 6-(2-hydroxy-ethoxy)-1-methyl-1,3-dihydro-benzoimidazol-2-one (0.41 g, 1.97 mmol) in anhydrous pyridine (30 ml) and cooled in 0 °C in an ice bath was added p-toluenesulfonic anhydride (0.86 g, 97%, 2.56 mmol), and the reaction was allowed to warm to rt while stirring under nitrogen overnight. The solvent was evaporated, and ethyl acetate (100 ml) and 1N HCl (100 ml) was added. The resulting emulsion was filtered, and the solid was washed with tetrahydrofuran. The filtrate layers were separated. The organic layer was washed with brine (75 ml), dried over  $\text{MgSO}_4$ ,

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filtered and evaporated to give toluene-4-sulfonic acid 2-(3-methyl-2-oxo-2,3-dihydro-1H-benzoimidazol-5-yloxy)-ethyl ester (0.52g, 73%), which was used without further purification.

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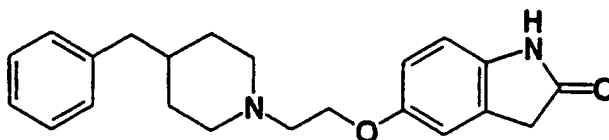
h) A suspension of toluene-4-sulfonic acid 2-(3-methyl-2-oxo-2,3-dihydro-1H-benzoimidazol-5-yloxy)-ethyl ester (0.52 g, 1.43 mmol), 4-benzylpiperidine (0.31 ml, 1.76 ml), and potassium carbonate (0.39 g, 10 2.99 mmol) in acetonitrile (100 ml) was refluxed under nitrogen for 8 h. Dimethylformamide (10 ml) was added, and refluxing was continued for 36 h. The solid was filtered off and washed with methanol. The filtrate was evaporated, and the solid was chromatographed on 15 silica gel eluting with 10% methanol/ethyl acetate to give the title compound (0.21 g, 40%) as a solid. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 9.63 (1H, s), 7.30-7.25 (2H, m), 7.19 (1H, d, J=6.7), 7.13 (2H, d, J=7.3), 6.94 (1H, d, J=8.5), 6.59 (1H, d, J=8.6), 6.56 (1H, s), 4.15-4.03 (3H, m), 20 3.37 (3H, s), 3.08 (2H, d, J=11.3), 2.86 (2H, t, J=5.8), 2.54 (2H, d, J=6.8), 2.13 (2H, t, J=11.2), 1.67 (2H, d, J=13.3), 1.60-1.53 (1H, m), 1.40 (2H, m). The free base (0.21 g, 0.57 mmol) was dissolved in ethyl acetate (3 ml). Oxalylic acid was dissolved in ethanol 25 (1 ml) and added to the ethyl acetate solution. The solid was filtered, washed with ethyl acetate, and dried in vacuo at 70 °C overnight to give the salt (0.21 g, 81%), mp 193-197 °C. Analysis calculated for C<sub>22</sub>H<sub>27</sub>N<sub>3</sub>O<sub>2</sub>•1.3 C<sub>2</sub>H<sub>2</sub>O<sub>4</sub>•0.07 H<sub>2</sub>O: C, 61.07; H, 6.20; N, 8.69. 30 Found: C, 61.12; H, 6.20; N, 8.69.

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## Example 194

4-Benzyl-1-(2-(2-oxo-1,3-dihydroindol-5-  
oxy)ethyl)piperidine

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a) From 4-methyl-3-nitrophenol (9.48 g, 61.90 mmol), triphenylphosphine (19.60 g, 74.73 mmol), and 2-benzyloxyethanol (9.83 g, 64.59 mmol) in tetrahydrofuran (130 ml) with DEAD (12.4 ml, 95%, 74.81 mmol) was obtained 2-methyl-1-nitro-4-[2-(phenylmethoxy)ethoxy]benzene (14.06 g, 79%) as a yellow oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 8.04 (1H, d, J=9.77), 7.35-7.25 (5H, m), 6.80-6.77 (2H, m), 4.59 (2H, s), 4.17 (2H, m), 3.82 (2H, m), 2.58 (3H, s).

b) To a suspension of sodium hydride (1.62 g, 60%, 40.5 mmol) in 20 ml of anhydrous THF at room temperature was added ethanol (2.5 ml) slowly. Diethyl oxalate (5.5 ml, 40.50 mmol) and 2-methyl-1-nitro-4-[2-(phenylmethoxy)ethoxy]benzene (10.19 g, 35.49 mmol) was added to the solution slowly after hydrogen evolution subsided. The reaction was heated at 60 °C for 2 h. The deep red solution was cooled to 0°C and quenched with 50 ml of 3N HCl solution. Brine (50 ml) was added and the mixture was extracted with EtOAc (2 x 100 ml). The combined organic layers was dried with MgSO<sub>4</sub>, filtered and concentrated. The brown oil was chromatographed on silica gel with 20% ethyl acetate in hexanes to elute out starting material and then with 35% ethyl acetate in hexanes to give 9.93g (72%) of 3-[5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-2-oxo-propionic acid ethyl ester as a yellow oil. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 8.18 (1H, d, J=9.29), 7.35-7.25 (5H, m), 6.91 (1H, dd, J=



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9.29, 2.69), 6.77 (1H, d, J=2.69), 4.59 (2H, s), 4.44 (2H, s), 4.35 (2H, q, J= 7.32), 4.19 (2H, m), 3.81 (2H, m), 1.37 (3H, t, J= 7.32).

5 c) To a solution of 3-[5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-2-oxo-propionic acid ethyl ester (37.77 g, 97.50 mmol) in methanol (370 ml) was added 1 N lithium hydroxide solution (230 ml, 0.23 mol). The deep red reaction mixture was stirred at 55°C for 30 min and  
10 worked up to give [5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-acetic acid (22.42 g, 69%) as an off-white solid. Analysis calculated for  $C_{17}H_{17}NO_6$ : C, 61.63; H, 5.17; N, 4.23. Found: C, 61.66; H, 5.08; N, 4.18.

d) A mixture of [5-(2-benzyloxy-ethoxy)-2-nitro-phenyl]-acetic acid (0.58 g, 1751 mmol), 5% palladium on carbon (0.05 g) and triethylamine (0.37 ml, 2.66 mmol) in methanol (35 ml) was stirred under a hydrogen atmosphere (1 atm) for 3 h. After removal of the catalyst by filtration, the filtrate was evaporated to  
15 give a yellow oil. The oil was dissolved in 10 ml of acetic acid and the solution was stirred at 80 °C under argon for 3 h. The acetic acid was removed on a rotavap. The residue was dissolved in a small amount of methylene chloride and chromatographed on silica gel  
20 eluted with 30% ethyl acetate in methylene chloride to give 5-(2-benzyloxy-ethoxy)-1,3-dihydro-indol-2-one (0.39g, 79%) as a white solid. Analysis calculated for  $C_{17}H_{17}NO_3$ : C, 72.07; H, 6.05; N, 4.85. Found: C, 72.09; H, 6.01; N, 4.85.

30

e) A mixture of 5-(2-benzyloxy-ethoxy)-1,3-dihydro-indol-2-one (3.20 g, 11.29 mmol), 20% palladium on carbon (0.38 g) and 8 drops of 1 N HCl solution in methanol (360 ml) was stirred under a hydrogen  
35 atmosphere (1 atm) overnight. After removal of the catalyst by filtration, the filtrate was evaporated to give a pale yellow solid. The solid was triturated

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with ethyl acetate and collected by filtration. 5-(2-Hydroxy-ethoxy)-1,3-dihydro-indol-2-one (1.52 g, 70%) was collected after air dried as an off-white solid. Analysis calculated for  $C_{10}H_{11}NO_3$ : C, 62.17; H, 5.74; N, 5 7.25. Found: C, 61.90; H, 5.82; N, 7.15.

f) 5-(2-Hydroxy-ethoxy)-1,3-dihydro-indol-2-one (0.70 g, 3.62 mmol) was dissolved in anhydrous pyridine (15 ml) and cooled to 0 °C in an ice bath. p-  
10 Toluenesulfonic anhydride (1.42 g, 97%, 4.22 mmol) was added, and the reaction was allowed to stir at 0 °C for 40 min. Ethyl acetate (100 ml) was added to precipitate pyridinium tosylate. The solid material was removed by filtration. The filtrate was washed  
15 with ice cold 3N HCl (2 x 30 ml) and then with brine. The organic layer was dried over  $MgSO_4$ , filtered and evaporated to give a pale brown solid. The solid was triturated with a mixture of EtOAc (6 ml) and  $Et_2O$  (40 ml) to give toluene-4-sulfonic acid 2-(2-oxo-2,3-  
20 dihydro-1H-indol-5-yloxy)-ethyl ester (0.77g, 61%) after air-dried, which was used without further purification.

g) A suspension of toluene-4-sulfonic acid 2-(2-oxo-  
25 2,3-dihydro-1H-indol-5-yloxy)-ethyl ester (0.84 g, 2.42 mmol), 4-benzylpiperidine (1.32 ml, 7.53ml), and potassium carbonate (2.70 g, 19.54mmol) in acetonitrile (84 ml) was refluxed overnight under argon. The reaction mixture was cooled to room temperature and the  
30 solid was filtered off and washed with THF (3x60 ml). The filtrate was evaporated, and the red colored oil was chromatographed on silica gel eluting with 35% methanol/ethyl acetate to give a tan solid (0.51 g, 60%). This material was dissolved in a mixture of  
35 methanol (3 ml) and ethyl acetate (6 ml). A solution of oxalic acid (0.19 g) in methanol (1 ml) was added slowly. The mixture was stirred at room temperature

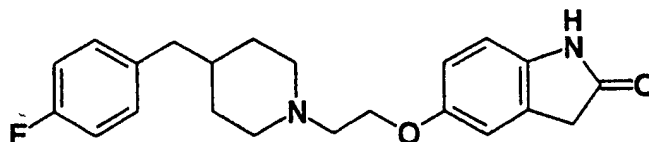
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for 5 min then at 0 °C for 5 min. The precipitates was collected and washed with ethyl acetate (3x5ml). The solid was dried overnight in a vacuum oven at 70 °C to give the oxalate salt of the title compound (0.55 g, 55%) as a tan solid, mp 210-211 °C. Analysis calculated for  $C_{22}H_{26}N_2O_2 \cdot 1.1 C_2H_2O_4$ : C, 64.66; H, 6.32; N, 6.23. Found: C, 64.66; H, 6.40; N, 6.19.

## Example 195

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4-(4-Fluorobenzyl)-1-(2-(2-oxo-1,3-dihydroindol-5-oxo)ethyl)piperidine



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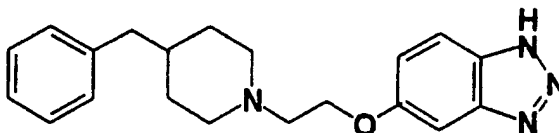
A suspension of toluene-4-sulfonic acid 2-(2-oxo-2,3-dihydro-1H-indol-5-yloxy)-ethyl ester (0.77 g, 2.22 mmol), 4-(4-fluorobenzyl)piperidine (1.1 g, 5.63 mmol), and potassium carbonate (2.2 g, 15.92 mmol) in acetonitrile (75 ml) was refluxed overnight under argon. The reaction mixture was cooled to room temperature and the solid was filtered off and washed with THF (3 x 20 ml). The filtrate was evaporated, and the solid chromatographed on silica gel eluting with 35% methanol/ethyl acetate to give the title compound (0.62 g, 76%) as a solid, mp 149-150°C. Analysis calculated for  $C_{22}H_{23}FN_2O_2 \cdot 0.14 H_2O$ : C, 71.21; H, 6.87; N, 7.55; F, 5.12. Found: C, 71.21; H, 6.68; N, 7.49; F, 5.26.

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## Example 196

## 4-Benzyl-1-(2-(1H-benzotriazol-5-oxy)ethyl)piperidine



5

- a) Raney nickel (10.95g) was washed with water (4 x 300 ml) then with methanol (4 x 300 ml). The catalyst was suspended in 450 ml of methanol and 4-(2-bromoethoxy)-6-nitroaniline (5.08g, 19.46 mmol) was added. The reaction mixture was stirred under a hydrogen atmosphere (1 atm) at room temperature for 1.5h. After removal of the catalyst by filtration, the filtrate was evaporated to give a black residue. The black residue was redissolved in a mixture of ethyl acetate (200 ml) and methanol (50 ml). Etheral HCl solution (1N, 40 ml) was added slowly to precipitate the diamine as the hydrochloride salt. The purple solid was collected and dissolved in a mixture of acetic acid (25 ml) and water (50 ml). The reaction mixture was cooled to 5°C in an ice-bath. A solution of sodium nitrite (1.75g, 25.36 mmol) in 10 ml water was added slowly into the reaction mixture. The mixture was heated at 80°C for 3h. The solid was collected by filtration and washed with water (3 x 30 ml). The solid was dissolved in THF and dried over magnesium sulphate, filtered and concentrated. The residue was chromatographed on silica gel eluted with 50% ethyl acetate in hexanes to give 2.15g of 6-(2-bromoethoxy)-1H-benzotriazole as a white solid. <sup>1</sup>H NMR (CDCl<sub>3</sub>) 7.86 (1h, d, J=9.03), 7.11-7.05 (2H, m), 4.34 (2H, t, J=6.10), 3.67 (2H, t, J=6.10).

- b) A suspension of 6-(2-bromoethoxy)-1H-benzotriazole (0.31 g, 1.28 mmol), 4-benzylpiperidine (0.45g, 2.57

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mmol), triethyl amine (0.75 ml, 5.38 mmol), 18-C-6 (cat. amount) and potassium iodide (cat. amount) in THF (50 ml) was refluxed overnight under argon. The reaction mixture was cooled to room temperature and concentrated on a rotavap. The residue was chromatographed on silica gel eluting with 35% methanol/ethyl acetate to give a tan solid (0.47 g). This material was dissolved in ethyl acetate (15 ml). A solution of oxalic acid (0.18 g) in methanol (2 ml) was added slowly. The mixture was stirred at room temperature for 5 min. then at 0°C for 5 min. The precipitate was collected and washed with ethyl acetate (3 x 5 ml). The solid was dried overnight in a vacuum oven at 70°C to give the oxalate salt of the title compound (0.37 g) as a tan solid: mp 164-166°C. Analysis calculated for  $C_{20}H_{24}N_4O \cdot 1.28 C_2H_2O_4$ : C, 60.00; H, 5.93; N, 12.41 Found: C, 60.00; H, 5.88; N, 12.68.

Other exemplary compounds of this invention are set forth below in Tables 1 and 2.

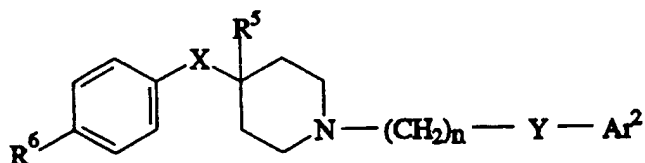
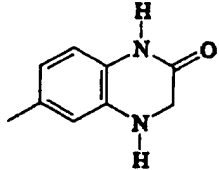
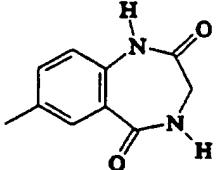
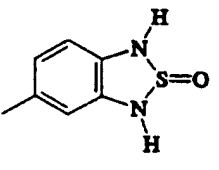
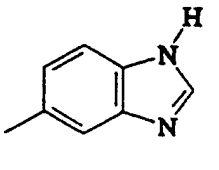
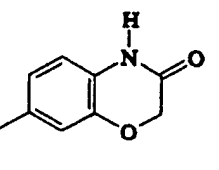
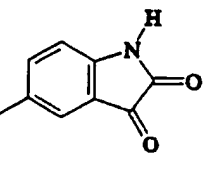
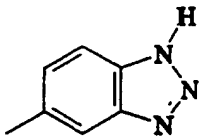
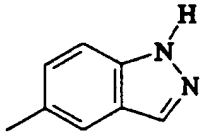
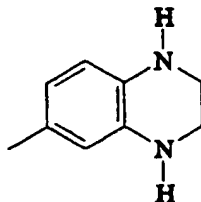
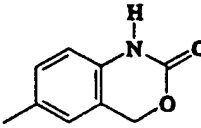
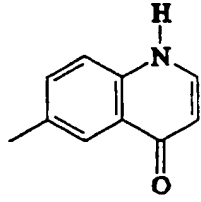
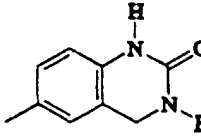

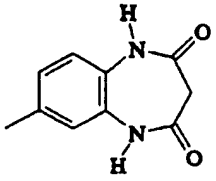
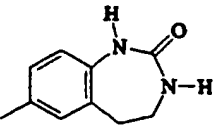
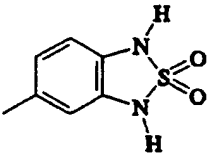
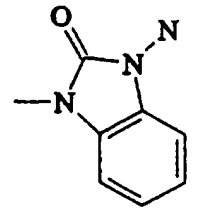
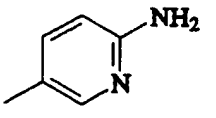


Table 1

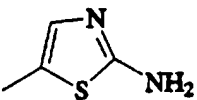
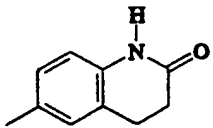
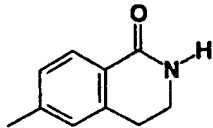
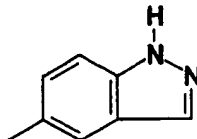
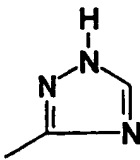
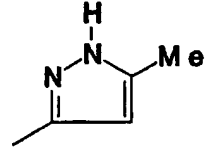
Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
197	H	CH <sub>2</sub>	H	2	O	

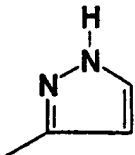
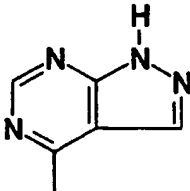
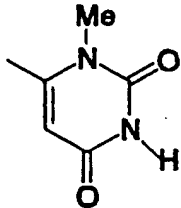
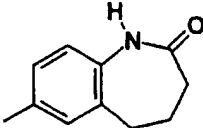
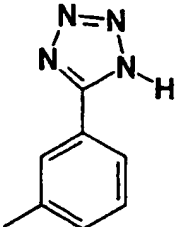
Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
198	F	S	H	2	O	
199	Me	O	H	3	S	
200	Cl	NH	H	3	NH	
201	MeO	CH <sub>2</sub>	OH	2	O	
202	F	CH <sub>2</sub>	H	4	NMe	
203	Et	O	H	2	S	

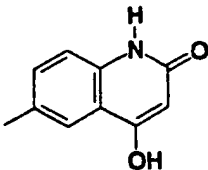
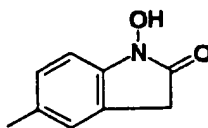
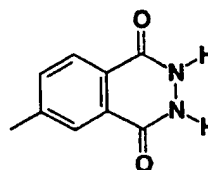
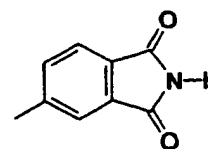
Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
204	Cl	NMe	H	3	O	
205	Me	CH <sub>2</sub>	H	2	NAc	
206	H	S	H	4	O	
207	MeO	CH <sub>2</sub>	OH	3	NH	
208	F	O	H	2	O	
209	F	CH <sub>2</sub>	H	3	S	

Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
210	Cl	CH <sub>2</sub>	H	2	O	
211	i-Pr	CH <sub>2</sub>	OH	3	S	
212	Me	S	H	4	O	
213	OH	CH <sub>2</sub>	H	3	NMe	
214	H	CH <sub>2</sub>	OH	2	O	
215	Cl	O	H	2	NAC	



Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
216	F	CH <sub>2</sub>	H	3	O	
217	H	CH <sub>2</sub>	H	2	O	
218	F	S	H	3	HN	
219	MeO	NH	H	2	NBz	
220	Cl	O	H	4	NAc	
221	H	CH <sub>2</sub>	OH	3	NMe	

Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
222	Cl	S	H	2	O	
223	MeO	O	H	3	NH	
224	F	CH <sub>2</sub>	H	4	S	
225	H	CH <sub>2</sub>	OH	4	NAC	
226	F	CH <sub>2</sub>	OH	2	O	

Example	R <sup>6</sup>	X	R <sup>5</sup>	n	Y	Ar <sup>2</sup>
227	HO	CH <sub>2</sub>	H	3	O	
228	Cl	O	H	2	O	
229	H	CH <sub>2</sub>	OH	4	NH	
230	MeO	CH <sub>2</sub>	H	3	O	

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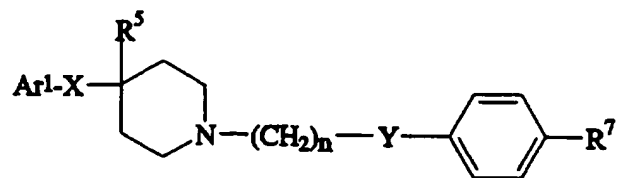
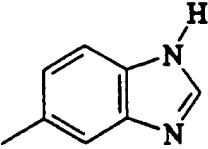
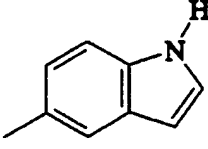
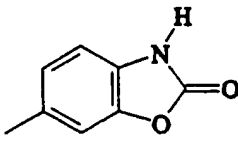
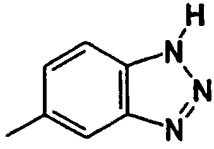
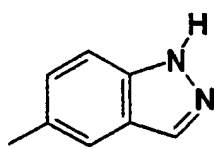
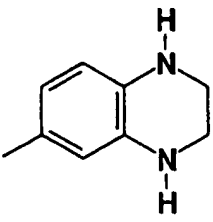
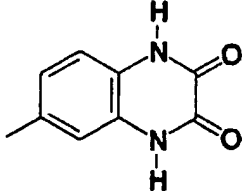
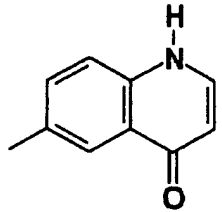
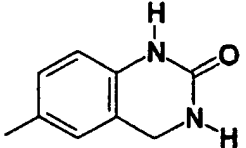
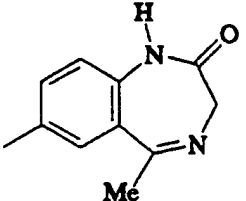
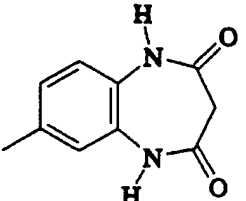


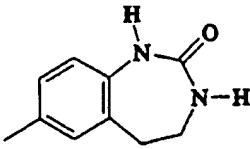
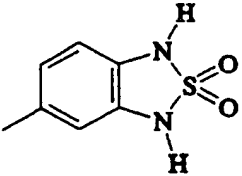
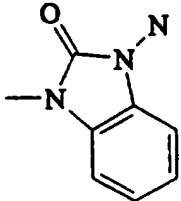
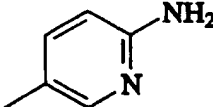
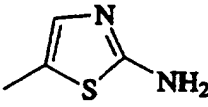
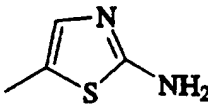
Table 2

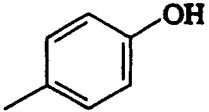
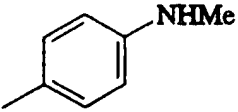
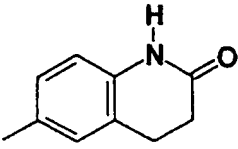
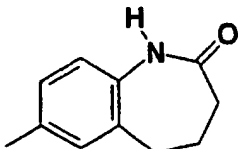
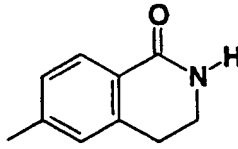
Example	$\text{Ar}^1$	X	$\text{R}^5$	n	Y	$\text{R}^7$
231		$\text{CH}_2$	H	2	O	H
232		S	H	2	O	F
233		O	H	3	S	Me
234		NH	H	3	NH	Cl

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Example	Ar <sup>1</sup>	X	R <sup>5</sup>	n	Y	R <sup>7</sup>
235		CH <sub>2</sub>	OH	2	O	MeO
236		CH <sub>2</sub>	H	4	NMe	F
237		O	H	2	S	Et
238		NMe	H	3	O	Cl
239		CH <sub>2</sub>	H	2	NAC	Me
240		S	H	4	O	H

Example	Ar <sup>1</sup>	X	R <sup>5</sup>	n	Y	R <sup>7</sup>
241		CH <sub>2</sub>	OH	3	NH	MeO
242		-	H	2	O	F
243		CH <sub>2</sub>	H	3	S	F
244		CH <sub>2</sub>	H	2	O	Cl
245		-	OH	3	S	i-Pr

Example	Ar <sup>1</sup>	X	R <sup>5</sup>	n	Y	R <sup>7</sup>
246		S	H	4	O	Me
247		-	H	3	NMe	OH
248		CH <sub>2</sub>	OH	2	O	H
249		O	H	2	NAc	Cl
250		CH <sub>2</sub>	H	3	O	F
251		-	OH	2	O	H

Example	Ar <sup>1</sup>	X	R <sup>5</sup>	n	Y	R <sup>7</sup>
252		-	H	2	O	Cl
253		O	H	3	NH	MeO
254		CH <sub>2</sub>	H	3	NH	F
255		-	H	2	O	OH
256		S	H	4	Nac	Me

The binding data for certain compounds described above in the expressed cloned NMDA subtypes as well as MES data is shown below in Table 3.



Table 3

		Subunits (IC <sub>50</sub> (μM))			
Compound		1A/2A	1A/2B	1A/2C	MES ED <sub>50</sub> (mg/kg)
5	Ex. 1	>100	0.8	>100	2
	Ex. 2	89	1.1	>100	3
	Ex. 3	35	2.8	>100	2
	Ex. 4	>100	9	>100	-
	Ex. 7	>100	10	>100	-
10	Ex. 9	>100	10	>100	-
	Ex. 11	>100	10	>100	-
	Ex. 12	>100	6	>100	-
	Ex. 13	90	1.3	>100	6
	Ex. 14	>100	3	>100	-
15	Ex. 15	100	1.2	>100	100
	Ex. 16	100	0.5	>100	2.5
	Ex. 17	100	3	>100	-
	Ex. 18	60	0.4	>100	6
	Ex. 19	>100	0.35	-	6
20	Ex. 20	5.5	0.7	>100	-
	Ex. 21	45	2.5	>100	-
	Ex. 22	90	0.9	>100	4
	Ex. 24	70	1	100	2
	Ex. 25	60	1	80	4
25	Ex. 26	>100	12	>100	-
	Ex. 27	>100	5	>100	5
	Ex. 28	38	0.4	>100	5
	Ex. 29	>100	0.5	>100	-
	Ex. 30	50	0.8	100	6
30	Ex. 31	34	0.9	60	7.5
	Ex. 33	>100	2	>100	4
	Ex. 34	>100	15	>100	-
	Ex. 35	>100	4	>100	-

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		Subunits (IC <sub>50</sub> (μM))			
Compound		1A/2A	1A/2B	1A/2C	MES ED <sub>50</sub> (mg/kg)
5	Ex. 36	40	22	>100	-
	Ex. 37	14	10	>100	-
	Ex. 38	75	45	>100	10
	Ex. 39	>100	60	>100	-
	Ex. 40	80	3	100	2.5
10	Ex. 41	90	5.0	>100	-
	Ex. 46	>100	1.5	>100	-
	Ex. 47	85	3	>100	3.2
	Ex. 48	>100	22	>100	-
	Ex. 49	>100	5	>100	-
15	Ex. 50	75	5	>100	-
	Ex. 51	80	5	>100	-
	Ex. 52	60	9.5	>100	-
	Ex. 53	100	0.31	>100	2.5
	Ex. 54	60	3.6	>100	-
20	Ex. 55	50	0.11	>100	6
	Ex. 56	90	1.1	>100	-
	Ex. 57	100	0.3	>100	6.5
	Ex. 58	25	0.1	>100	5.1
	Ex. 59	75	0.024	>100	1
25	Ex. 60	>100	6	>100	-
	Ex. 61	100	0.3	>100	2.5
	Ex. 62	80	6	>100	-
	Ex. 63	100	0.5	>100	3
	Ex. 64	>100	6	>100	-
30	Ex. 65	90	1.3	>100	6
	Ex. 66	>100	10	>100	-
	Ex. 67	>100	0.32	>100	6
	Ex. 68	>100	5	>100	-
	Ex. 69	20	0.43	>100	-

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	Compound	Subunits (IC <sub>50</sub> (μM))			MES ED <sub>50</sub> (mg/kg)
		1A/2A	1A/2B	1A/2C	
	Ex. 70	>100	1	>100	1.5
	Ex. 71C	>100	8	>100	-
	Ex. 71A	>100	20	>100	-
	Ex. 73	30	8	100	8
5	Ex. 74	60	3	>100	3.5
	Ex. 77	50	0.11	>100	6
	Ex. 80	16	0.025	70	-
	Ex. 83	>100	1.0	>100	2
	Ex. 84	>100	2.2	>100	-
10	Ex. 90	>100	5	>100	5
	Ex. 91	>100	22	>100	-
	Ex. 96	>100	17	>100	3.5
	Ex. 98	80	100	80	
	Ex. 99	>300	0.03	>300	2.0
15	Ex. 101	55	0.05	240	3.0
	Ex. 102	60	0.02	290	3.0
	Ex. 103	95	1	>300	3.0
	Ex. 104	50	0.2	>300	3.0
	Ex. 106	90	0.02	260	
20	Ex. 107	60	0.03	270	
	Ex. 108	62	0.25	>300	
	Ex. 112	30	0.08	280	4.5
	Ex. 113	200	30	200	
	Ex. 115	75	0.03	220	0.7
25	Ex. 116	70	4.5	150	3.0
	Ex. 120	55	0.02	>300	2.0
	Ex. 121	110	0.05	>300	2.5
	Ex. 122	55	0.18	280	5.0
	Ex. 123	50	0.07	>300	3.0
30	Ex. 125	75	3.3	>300	15

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	Compound	Subunits (IC <sub>50</sub> (μM))			MES ED <sub>50</sub> (mg/kg)
		1A/2A	1A/2B	1A/2C	
	Ex. 127	70	5.0	>300	
	Ex. 128	110	0.04	>300	1.0
	Ex. 129	170	0.05	170	2.0
	Ex. 131	50	0.05	>300	1.5
5	Ex. 132	23	0.16	230	1.0
	Ex. 133	80	0.21	150	2.5
	Ex. 134	60	0.03	140	1.5
	Ex. 139	70	0.25		4.5
	Ex. 140	80	28		
10	Ex. 141	100	0.1	90	
	Ex. 143	190	0.4	>300	0.5
	Ex. 144	>300	1.6	>300	
	Ex. 146	30	0.01	160	0.8
	Ex. 147	40	0.1	210	3.0
15	Ex. 148	105	3.8	135	
	Ex. 149	50	0.04	140	2.0
	Ex. 150	100	0.02	>300	3.0
	Ex. 151	52	0.02	100	2.5
	Ex. 152	90	0.04	200	
20	Ex. 153	65	0.04	70	
	Ex. 154	250	0.02	230	1.5
	Ex. 155	170	0.03	>300	
	Ex. 158	100	0.3	190	
	Ex. 159	130	0.5	140	
25	Ex. 160	60	0.2	120	
	Ex. 161	85	0.04	170	
	Ex. 163	35	0.1	>300	
	Ex. 164	100	0.12	>300	
	Ex. 165	65	0.05	301	0.5
30	Ex. 166	270	170	>300	0.7

Compound	Subunits (IC <sub>50</sub> (μM))			MES ED <sub>50</sub> (mg/kg)
	1A/2A	1A/2B	1A/2C	
Ex. 167	110	0.02	301	0.3
Ex. 168	>300	9.5	>300	4.0
Ex. 170	62	0.04	230	10
Ex. 171	72	0.04	170	5.0
5 Ex. 172	140	0.11	50	
Ex. 174	35	0.03	45	5.0
Ex. 175	48	0.02	70	8.0
Ex. 176	25	0.03	50	7.5
Ex. 177	35	0.1	210	5.0
10 Ex. 181	110	1.0	140	6.0
Ex. 182	43	1.0	210	>20
Ex. 189	7.0	0.1	130	7.0
Ex. 191	25	0.1	>300	
Ex. 192	>300	0.1	>300	
15 Ex. 193		0.2	>300	
Ex. 194	>300	0.06	>300	2.5
Ex. 195	>300	0.07	>300	

20 The data shows that 4-substituted piperidine analogs of this invention exhibit selectivity for 2B subtype receptors compared to 2A and 2C subtype receptors, and many of these compounds are active as anticonvulsants in the MES assay.

25

In vivo data is presented below. The compound of Example 1 (4-benzyl-1-(2-phenoxyethyl)piperidine) was administered (2.5 mg/Kg i.v. bolus, 0.5 mg/ml solution) to rats immediately after MCA-O. The compound was then  
 30 administered continuously at a rate of 1.75 mg/Kg for 22 hours. The results shown in table 4 and Figure 1

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show that the compound gave significant protection from ischemia.

5

Table 4

10

Region in the Brain	Mean Infarct Volume in mm <sup>3</sup>		% of Ischemia Protection
	Vehicle n=13	Drug n=12	
Cortex	120.450±20.166	50.450±11.428	58%*(p=0.0071)
Subcortex	74.462±7.481	67.400±6.775	9.5%(p=0.4936)

15 \* : Statistically significant  $p \leq 0.05$   
All numerical values of the parameters in the above table are expressed as the mean  $\pm$  S.E.M.

20 The compound of Example 25 (4-(4-chlorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine hydrobromide was administered (10 mg/Kg i.v. bolus, 2.5 mg/ml solution) immediately after MCA-O. The results shown in Table 5 and Figure 2 show that the compound gave significant  
25 protection from ischemia.

Table 5

30

Region in the Brain	Mean Infarct Volume in mm <sup>3</sup>		% of Ischemia Protection
	Vehicle n=11	Drug n=7	
Cortex	114.936±22.3	41.857±19.984	64%*(p=0.0381)
Subcortex	81.564±5675	43.343±17.37	47%(p=.0320)

35

\* : Statistically significant  $p \leq 0.05$   
All numerical values of the parameters in the above table are expressed as the mean  $\pm$  S.E.M.

40

Other variations and modifications of this invention will be obvious to those skilled in this art. This

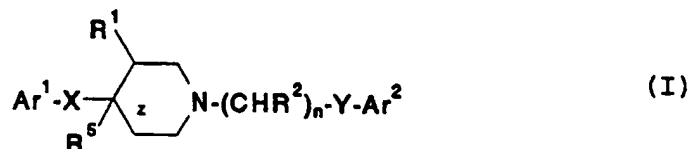
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invention is not limited except as set forth in the following claims.

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## WHAT IS CLAIMED IS:

1. A compound represented by the formula (I)



or a pharmaceutically acceptable salt thereof wherein  
 $\text{Ar}^1$  and  $\text{Ar}^2$  are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

$z$  is a single or double bond;

$X$  is  $-(\text{CHR}^3)_m-$ , O, S or  $\text{NR}^4$ , wherein each  $\text{R}^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $\text{R}^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and  $m$  is 0, 1 or 2, provided that when  $z$  is a double bond then  $X$  is not O or  $\text{NR}^4$ ;

$\text{R}^1$  is independently hydrogen or hydroxy;

each  $\text{R}^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4;

$Y$  is O, S,  $\text{NR}^4$  or a single bond; and

$\text{R}^5$  is hydrogen or hydroxy when  $z$  is a single bond, provided that: (i)  $\text{R}^2$  cannot be hydroxy in a position alpha to  $\text{Ar}^2$ ; (ii) if  $X$  is a single bond,  $z$  is a double bond or  $\text{R}^5$  is hydroxy and  $\text{Ar}^2$  is phenyl then  $Y$  cannot be O; (iii) if  $Y$  is O,  $n$  is 3 or 4,  $\text{R}^2$  is exclusively hydrogen,  $z$  is a single bond,  $\text{R}^1$  and  $\text{R}^5$  are hydrogen and  $\text{Ar}^2$  is phenyl, or halogen, methoxy or trifluoromethyl substituted phenyl then  $X$  cannot be methylene or



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ethylene; (iv) if X is  $-(CHR^3)_m-$ , m is 2 and  $R^3$  is exclusively hydrogen then  $Ar^1$  cannot be imidazolyl substituted; (v) if Y is O, n is 2, 3 or 4,  $R^2$  is hydrogen or hydroxy, z is a single bond,  $R^1$  and  $R^5$  are hydrogen and  $Ar^2$  is phenyl, or  $NO_2$ , CN, 1-imidazolyl, or 1,2,4-triazol-1-yl substituted phenyl then X cannot be methylene, hydroxymethylene, or O; (vi) if Y is O or S,  $R^1$  and  $R^5$  are hydrogen and  $R^2$  is hydroxy then X is not methylene or a single bond; or (vii) if Y is a single bond,  $R^2$  is exclusively hydrogen and  $Ar^2$  is phenyl then either  $R^1$  or  $R^5$  must be hydroxy.

2. A compound according to claim 1, wherein Y is O or a single bond.

3. A compound according to claim 2, wherein  $Ar^2$  is a heteroaryl group.

4. A compound according to claim 2, wherein  $R^1$  or  $R^5$  is hydroxy.

5. A compound according to claim 1, said compound selected from the group consisting of:

4-Phenoxy-1-[(4-fluorophenoxy)propyl]piperidine;  
1-(3-Phenoxypropyl)-4-phenylpiperidine;  
1-(2-Phenoxyethyl)-4-phenylpiperidine;  
1-(4-Phenoxybutyl)-4-phenylpiperidine;  
1-(4-(3-(Trifluoromethyl)phenoxy)butyl)-4-phenylpiperidine;  
1-(2-(4-Aminophenoxy)ethyl)-4-benzylpiperidine;  
3-((2-(4-Benzylpiperidin-1-yl)ethyl)oxy)-benzaldehyde;  
3-((2-(4-Benzylpiperidin-1-yl)ethyl)oxy)-benzaldehyde oxime;  
4-Benzyl-1-(2-(3-(ethoxycarbonylmethyl)-phenoxy)ethyl)piperidine;

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4-Benzyl-1-(2-(3-(2-hydroxyethyl)phenoxy)ethyl)piperidine;  
1-(2-(3-(Aminocarbonylmethyl)phenoxy)ethyl)-4-benzylpiperidine;  
4-Benzyl-1-(2-(3-(hydrazinocarbonylmethyl)-phenoxy)ethyl)piperidine;  
4-Benzyl-1-(1-methyl-2-phenoxyethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(2-(4-fluorophenoxy)-ethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(2-(4-chlorophenoxyethyl)-piperidine;  
1-(2-(4-Aminophenoxy)ethyl)-4-(4-chlorobenzyl)-piperidine;  
4-(4-Chlorobenzyl)-1-(2-(3-(2-hydroxyethyl)phenoxy)-ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)-piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-chlorophenoxy)-ethyl)piperidine;  
1-(2-(4-Fluorophenoxy)ethyl)-4-(4-methoxybenzyl)-piperidine;  
1-(2-(4-Fluorophenoxy)ethyl)-4-(4-nitrobenzyl)-piperidine;  
4-Benzyl-1-(1-methyl-3-phenoxypropyl)piperidine;  
1-(2-Phenoxyethyl)-4-phenylpiperidine;  
3-Hydroxy-1-(2-phenoxyethyl)-4-(3-trifluoromethylphenyl)piperidine;  
3-Hydroxy-1-(3-phenoxypropyl)-4-(3-trifluoromethylphenyl)piperidine;  
4-Benzyl-1-[2-(6-quinolinoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(8-quinolinoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(2-amino-3-nitrophenoxy)ethyl]-piperidine;  
4-Benzyl-1-[2-(2,3-diaminophenoxy)ethyl]-piperidine;  
4-Benzyl-1-[2-(2,3-dioxoquinoxalin-5-oxo)-ethyl]piperidine;

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4-Benzyl-1-[2-(2-oxobenzimidazol-4-oxy)-ethyl]piperidine;  
4-Benzyl-1-[2-(4-amino-3-nitrophenoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(3,4-diaminophenoxy)-ethyl]piperidine;  
4-Benzyl-1-[2-(2,3-dioxoquinoxalin-6-oxy)-ethyl]piperidine;  
4-Benzyl-1-[2-(2-oxobenzimidazol-5-oxy)-ethyl]piperidine;  
4-Benzyl-1-[2-(2-aminophenoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(3-aminophenoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(4-aminophenoxy)ethyl]piperidine;  
4-[2-(4-Benzylpiperidinoethoxy)quinazoline;  
4-[2-(4-Benzylpiperidino)ethoxy]pyrazolo-[3,4-d]pyrimidine;  
1-[2-(4-Benzylpiperidino)-ethyl]-4-hydroxypyrazolo[3,4-d]pyrimidine;  
4-Benzyl-1-[2-(2-methoxyphenoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(3-methoxyphenoxy)ethyl]-piperidine;  
4-Benzyl-1-[2-(4-methoxyphenoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(3,4-bisacetamidophenoxy)ethyl]-piperidine;  
4-Benzyl-1-[2-(2-methylbenzimidazol-6-oxy)ethyl]piperidine;  
4-Benzyl-1-[2-(2-methylbenzimidazol-5-oxy)ethyl]piperidine;  
4-Benzyl-1-[2-(3-trifluoromethylphenoxy)-ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-nitrophenoxy)-ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-aminophenoxy)-ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-amino-3-nitrophenoxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2,3-diaminophenoxy)ethyl]piperidine;

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4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-4-oxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(4-amino-3-nitrophenoxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(3,4-diaminophenoxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine;  
4-(4-Fluorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine;  
4-(4-Chlorophenyl)-4-hydroxyl-1-(3-phenylpropyl)piperidine;  
4-(4-Chlorophenyl)-4-hydroxyl-1-(4-phenylbutyl)piperidine;  
3-Hydroxy-1-(4-phenylbutyl)-4-(3-trifluoromethylphenyl)piperidine;  
4-Benzyl-4-hydroxy-1-(2-phenylethyl)piperidine;  
1,4-Dibenzyl-4-hydroxypiperidine;  
1-Benzyl-4-(4-fluorobenzyl)-4-hydroxypiperidine;  
4-(4-Fluorobenzyl)-1-[2-(4-fluorophenyl)ethyl]-4-hydroxypiperidine;  
4-(2-Keto-1-benzimidazoliny)-1-(3-phenoxypropyl)-piperidine;  
4-Benzyl-4-hydroxy-1-(2-phenoxyethyl)piperidine;  
4-Benzyl-4-hydroxy-1-(3-phenylpropyl)piperidine;  
4-Benzyl-4-hydroxy-1-(3-phenoxypropyl)piperidine;  
4-Benzyl-1-[(2-hydroxy-4-phenyl)butyl]piperidine;  
3-Hydroxy-4-(3-trifluoromethylphenyl)-1-[3-(3-aminophenoxy)propyl]piperidine;  
3-Hydroxy-4-(4-fluorophenyl)-1-[3-(3-amino-1-naphthayloxy)propyl]piperidine;  
4-Benzyl-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;

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4-(4-Hydroxybenzyl)-1-(2-(4-fluorophenoxy)ethyl)  
piperidine;  
4-Benzyl-1-(3-(4-hydroxyphenyl)propyl)piperidine;  
4-(4-Chlorobenzyl)-1-(3-(4-hydroxyphenyl)propyl)  
piperidine;  
4-Benzyl-1-(2-(4-hydroxyphenyl)ethyl)piperidine;  
4-(3-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)  
piperidine;  
4-(3-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)  
piperidine;  
4-(4-Methylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Ethylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Methoxybenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)  
piperidine;  
4-(3,4-Difluorobenzyl)-1-(2-(4-hydroxyphenoxy)  
ethyl)piperidine;  
4-(4-Fluorobenzyl)-4-hydroxy-1-(2-(4-  
hydroxyphenoxy)ethyl)piperidine;  
4-(2-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Trifluoromethylbenzyl)-1-(2-(4-  
hydroxyphenoxy)ethyl)piperidine;  
4-(4-Isopropylbenzyl)-1-(2-(4-hydroxyphenoxy)  
ethyl)piperidine;  
4-(4-t-Butylbenzyl)-1-(2-(4-hydroxyphenoxy)  
ethyl)piperidine;  
4-(2-Fluoro-4-methylbenzyl)-1-(2-(4-  
hydroxyphenoxy)ethyl)piperidine;  
4-((5,6,7,8-Tetrahydro-2-naphthyl)methyl)-1-(2-(4-  
hydroxyphenoxy)ethyl)piperidine;  
4-((2-Naphthyl)methyl)-1-(2-(4-hydroxyphenoxy)  
ethyl)piperidine;  
4-Benzyl-1-(2-(N-methylanilino)ethyl)piperidine;  
4-Benzyl-1-(2-(thiophenoxy)ethyl)piperidine;

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4- (4-Chlorobenzyl) -1- (2- (2-chloro-4- (2-hydroxyethyl) phenoxy) ethyl) piperidine;

4- (2,6-Difluorobenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;

4- (2-Fluoro-4-methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;

4-Benzyl-1- (2- (3,4-methylenedioxyphenoxy) ethyl) piperidine;

4- (2-Fluoro-4-methylbenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;

4- (4-Fluorobenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;

4- (4-Methylbenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;

4- (4-Fluorobenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;

4- (4-Methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;

4-Hydroxy-4- (4-methylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;

4-Hydroxy-4- (4-methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;

4-Benzyl-1- (2- (2-hydroxyphenoxy) ethyl) piperidine;

4-Benzyl-1- (2- (3-hydroxyphenoxy) ethyl) piperidine;

4- (4-Fluorobenzyl) -1- (2- (2-hydroxyphenoxy) ethyl) piperidine;

4- (4-Fluorobenzyl) -1- (2- (3-hydroxyphenoxy) ethyl) piperidine;

4- (4-Methylbenzyl) -1- (2- (2-hydroxyphenoxy) ethyl) piperidine;

4- (4-Methylbenzyl) -1- (2- (3-hydroxyphenoxy) ethyl) piperidine;

4-Benzyl-1- (2- (N-methyl-4-hydroxyanilino) ethyl) piperidine;

4-Benzyl-4-hydroxy-1- (2- (4-hydroxyphenoxy) ethyl) piperidine;

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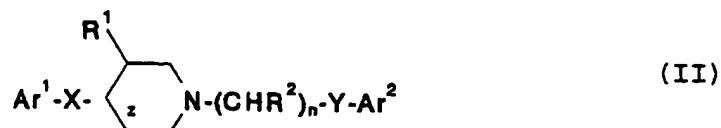
4-(4-Fluorobenzyl)-1-(2-(4-hydroxythiophenoxy)ethyl)piperidine;  
4-(4-Hydroxyphenyl)-1-(4-phenylbutyl)piperidine;  
4-Benzyl-1-(3-(2-oxobenzimidazol-5-oxy)propyl)piperidine;  
4-Benzyl-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(2-iminobenzimidazol-5-oxy)ethyl)piperidine;  
4-(4-Methylbenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(2-oxobenzoxazol-5-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(2-oxobenzoxazol-6-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(3-hydroxynaphth-6-oxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine;  
4-(4-Methylbenzyl)-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(3-methyl-2-oxobenzimidazol-5-oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(2-oxo-1,3-dihydroindol-5-oxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(2-oxo-1,3-dihydroindol-5-oxy)ethyl)piperidine; and a pharmaceutically acceptable salt of any thereof.

6. A pharmaceutical composition useful for treating disorders responsive to the selective blockade of N-

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methyl-D-aspartate receptor subtypes such as stroke, cerebral ischemia, central nervous systems, trauma, hypoglycemia, neurodegenerative disorders, anxiety, migraine headache, convulsions, aminoglycoside antibiotics-induced hearing loss, psychosis, glaucoma, CMV retinitis opioid tolerance or withdrawal, chronic pain, or urinary incontinence said compositions comprising a pharmaceutically acceptable carrier or diluent and a therapeutically effective amount of at least one compound of claim 1.

7. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

z is a single or double bond;

X is -(CHR<sup>3</sup>)<sub>m</sub>-, O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2, provided that when z is a double bond then X is not O or NR<sup>4</sup>;

R<sup>1</sup> is hydrogen or hydroxy;

each R<sup>2</sup> independently is hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and



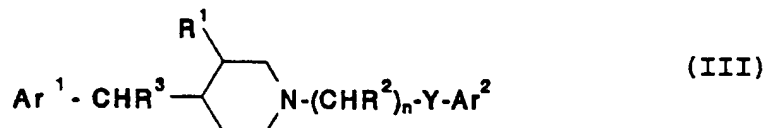
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Y is O, S, NR<sup>4</sup> or is a single bond, provided that:

(i) R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>;

(ii) if X is a single bond, z is a double bond and Ar<sup>2</sup> is phenyl then Y cannot be O; (iii) if Y is O, n is 3 or 4, R<sup>2</sup> is exclusively hydrogen, R<sup>1</sup> is hydrogen and Ar<sup>2</sup> is phenyl, or halogen, methoxy, or trifluoromethyl substituted phenyl then X cannot be methylene or ethylene; (iv) if X is -(CHR<sup>3</sup>)<sub>m</sub>-, m is 2 and R<sup>3</sup> is exclusively hydrogen then Ar<sup>1</sup> cannot be imidazolyl substituted; (v) if Y is O, n is 2, 3 or 4, R<sup>2</sup> is hydrogen or hydroxy, R<sup>1</sup> is hydrogen and Ar<sup>2</sup> is phenyl, or NO<sub>2</sub>, CN, 1-imidazolyl or 1,2,4-triazol-1-yl substituted phenyl then X cannot be methylene, hydroxymethylene or O; (vi) if Y is O or S, R<sup>1</sup> is hydrogen and R<sup>2</sup> is hydroxy then X is not methylene or a single bond; or (vii) if Y is a single bond, R<sup>2</sup> is exclusively hydrogen and Ar<sup>2</sup> is phenyl then R<sup>1</sup> must be hydroxy.

8. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein;

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

R<sup>1</sup> is hydrogen or hydroxy;

each R<sup>2</sup> and R<sup>3</sup> are independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

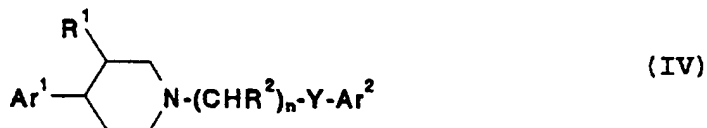
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n is 0, 1, 2, 3 or 4; and

Y is O, S, NR<sup>4</sup> or is a single bond provided that:

- (i) R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>;
- (ii) if Y is O, n is 3 or 4, R<sup>2</sup> is exclusively hydrogen, R<sup>1</sup> is hydrogen and Ar<sup>2</sup> is phenyl, or halogen, methoxy or trifluoromethyl substituted phenyl then X cannot be methylene or ethylene;
- (iii) if Y is O, n is 2, 3 or 4, R<sup>2</sup> is hydrogen or hydroxy, R<sup>1</sup> is hydrogen and Ar<sup>2</sup> is phenyl, or NO<sub>2</sub>, CN, 1-imidazolyl, or 1,2,4-triazol-1-yl substituted phenyl then R<sup>3</sup> cannot be hydrogen;
- (iv) if Y is O or S, R<sup>1</sup> is hydrogen and R<sup>2</sup> is hydroxy then R<sup>3</sup> cannot be hydrogen;
- or (v) if Y is a single bond, R<sup>2</sup> is exclusively hydrogen and Ar<sup>2</sup> is phenyl then R<sup>1</sup> must be hydroxy.

9. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof, wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

R<sup>1</sup> is hydrogen or hydroxy;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 1, 2, 3 or 4; and

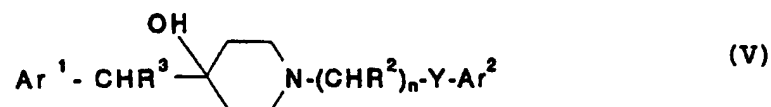
Y is O, S, NR<sup>4</sup> or is a single bond, provided that:

- (i) R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>; or

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(ii) if Y is a single bond, O or S and Ar<sup>2</sup> is phenyl then R<sup>1</sup> is not hydroxy.

10. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

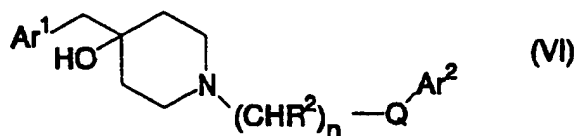
Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each R<sup>2</sup> and R<sup>3</sup> are independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and

Y is O, S, NR<sup>4</sup> or is a single bond provided that R<sup>2</sup> cannot be hydroxy in a position alpha to Ar<sup>2</sup>.

11. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl,

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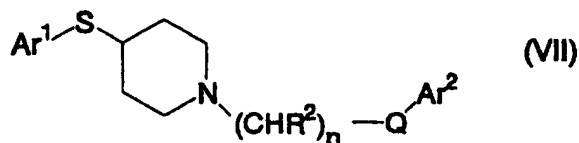
aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4; and

$Q$  is O, S,  $NR^4$  or is a single bond.

12. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof, wherein:

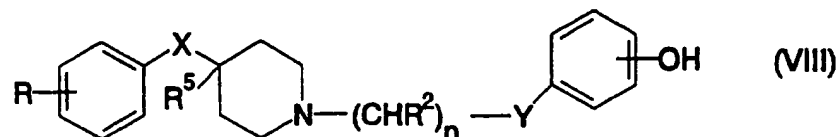
$Ar^1$  and  $Ar^2$  are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4; and

$Q$  is O, S,  $NR^4$  or is a single bond.

13. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

R is hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

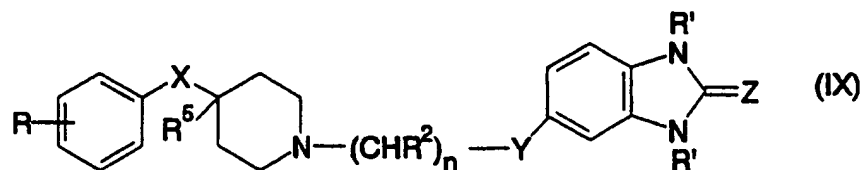
R<sup>5</sup> is hydrogen or hydroxy;

Y is O, S, NR<sup>4</sup> or is a single bond; and

X is -(CHR<sup>3</sup>)<sub>m</sub>-, O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2.

14. A compound of claim 13 wherein R<sup>5</sup> is hydroxy.

15. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

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R is hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

$R^3$  is hydrogen or hydroxy;

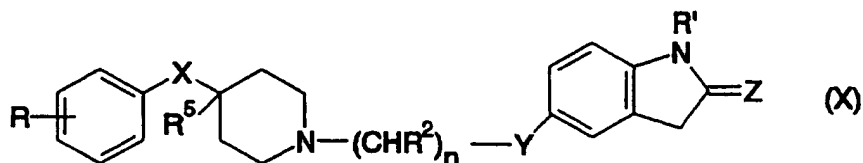
$R'$  independently is hydrogen or alkyl;

Z is O or S;

Y is O, S,  $NR^4$  or is a single bond; and

X is  $-(CHR^3)_m-$ , O, S or  $NR^4$ , wherein each  $R^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $R^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2.

16. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

R is hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

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$n$  is 0, 1, 2, 3 or 4;

$X$  is  $-(CHR^3)_m-$ , O, S or  $NR^4$ , wherein each  $R^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $R^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and  $m$  is 0, 1 or 2;

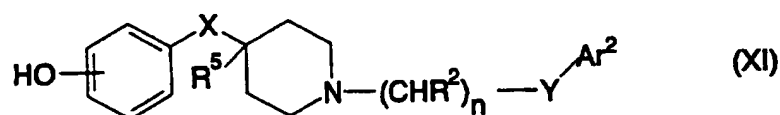
$R^5$  is hydrogen or hydroxy;

$R'$  is hydrogen or alkyl;

$Z$  is O or S; and

$Y$  is O, S,  $NR^4$  or is a single bond.

17. A compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

$Ar^2$  is aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4;

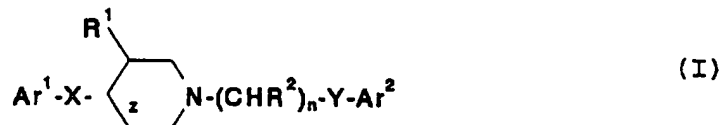
$X$  is  $-(CHR^3)_m-$ , O, S or  $NR^4$ , wherein each  $R^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $R^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and  $m$  is 0, 1 or 2;

$R^5$  is hydrogen or hydroxy; and

$Y$  is O, S,  $NR^4$  or is a single bond.

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18. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

z is a single or double bond;

X is  $-(\text{CHR}^3)_m-$ , O, S or NR<sup>4</sup>, wherein R<sup>3</sup> is hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2, provided that when z is a double bond then X is not O or NR<sup>4</sup>;

R<sup>1</sup> is hydrogen or hydroxy;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

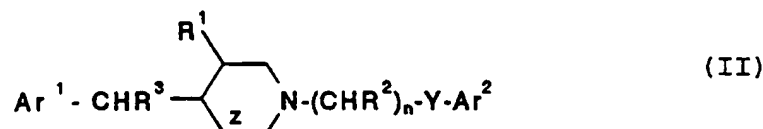
Y is O, S, NR<sup>4</sup> or is a single bond; and

R<sup>5</sup> is hydrogen or hydroxy when z is a single bond.

19. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one



selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

$\text{Ar}^1$  and  $\text{Ar}^2$  are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

X is  $-(\text{CHR}^3)_m-$ , O, S or  $\text{NR}^4$ , wherein  $\text{R}^3$  is hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $\text{R}^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2, provided that when z is a double bond then X is not O or  $\text{NR}^4$ ;

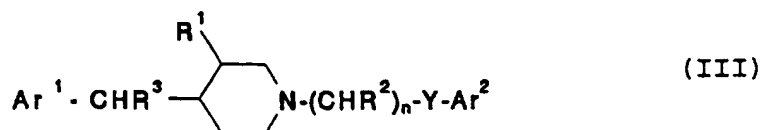
$\text{R}^1$  is hydrogen or hydroxy;

each  $\text{R}^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and

Y is O, S,  $\text{NR}^4$  or is a single bond.

20. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



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or a pharmaceutically acceptable salt thereof wherein;

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, benzaldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

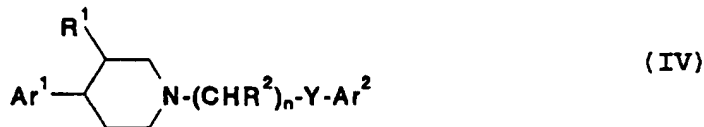
R<sup>1</sup> is hydrogen or hydroxy;

R<sup>2</sup> and R<sup>3</sup> are independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and

Y is O, S, NR<sup>4</sup> or is a single bond.

21. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof, wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

R<sup>1</sup> is hydrogen or hydroxy;

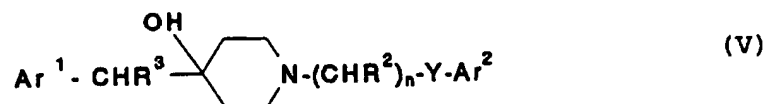
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each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 1, 2, 3 or 4; and

$Y$  is O, S,  $NR^4$  or is a single bond.

22. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof, wherein:

$\text{Ar}^1$  and  $\text{Ar}^2$  are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

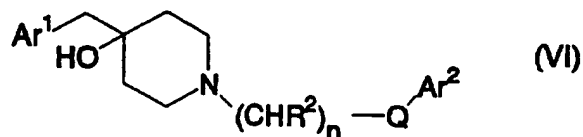
each  $R^2$  and  $R^3$  are independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4; and

$Y$  is O, S,  $NR^4$  or is a single bond.

23. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:

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or a pharmaceutically acceptable salt thereof wherein:

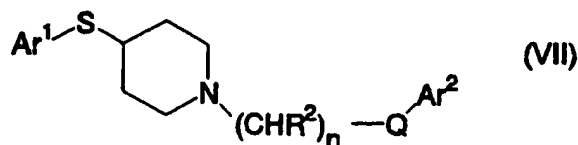
Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4; and

Q is O, S, NR<sup>4</sup> or is a single bond.

24. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof, wherein:

Ar<sup>1</sup> and Ar<sup>2</sup> are independently aryl or a heteroaryl group, either of which may be independently substituted

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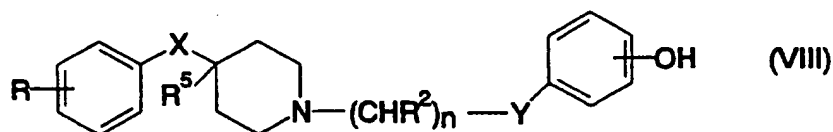
by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4; and

$Q$  is O, S,  $NR^4$  or is a single bond.

25. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

$R$  is hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4;

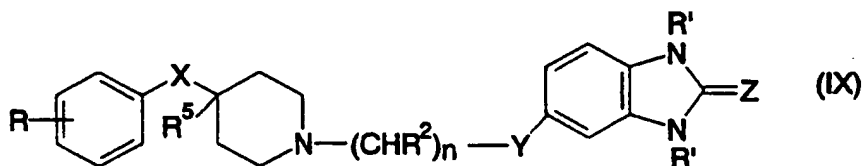
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$R^3$  is hydrogen or hydroxy;

$Y$  is O, S,  $NR^4$  or is a single bond; and

$X$  is  $-(CHR^3)_m-$ , O, S or  $NR^4$ , wherein each  $R^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $R^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and  $m$  is 0, 1 or 2.

26. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

$R$  is hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $R^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

$n$  is 0, 1, 2, 3 or 4;

$R^3$  is hydrogen or hydroxy;

$R^4$  independently is hydrogen or alkyl;

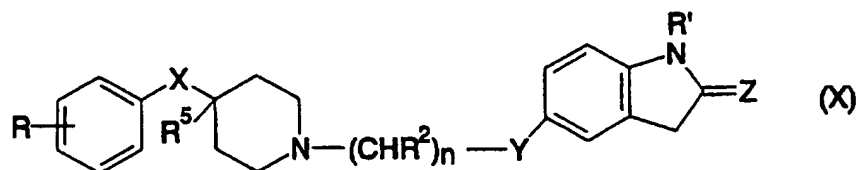
$Z$  is O or S;

$Y$  is O, S,  $NR^4$  or is a single bond; and

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X is  $-(\text{CHR}^3)_m-$ , O, S or  $\text{NR}^4$ , wherein each  $\text{R}^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $\text{R}^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2.

27. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

R is hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy, carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each  $\text{R}^2$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

X is  $-(\text{CHR}^3)_m-$ , O, S or  $\text{NR}^4$ , wherein each  $\text{R}^3$  is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms,  $\text{R}^4$  is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2;

$\text{R}^5$  is hydrogen or hydroxy;

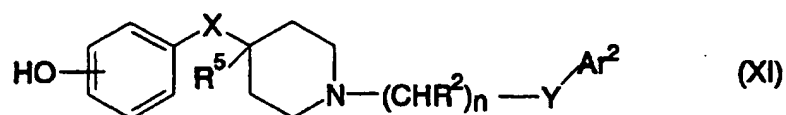
$\text{R}'$  is hydrogen or alkyl;

Z is O or S; and

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Y is O, S, NR<sup>4</sup> or is a single bond.

28. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one selective N-methyl-D-aspartate receptor subtype antagonist compound represented by the formula:



or a pharmaceutically acceptable salt thereof wherein:

Ar<sup>2</sup> is aryl or a heteroaryl group, either of which may be independently substituted by hydrogen, alkyl, hydroxy, halogen, nitro, cyano, carboxaldehyde, aldehyde oxime, lower alkoxy carbonylmethyl, hydroxy lower alkyl, aminocarbonylmethyl, hydrazinocarbonylmethyl, acetamido, aryl, aralkyl, amino, a halogenated alkyl group, a lower alkyl amino group or a lower alkoxy group;

each R<sup>2</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms;

n is 0, 1, 2, 3 or 4;

X is -(CHR<sup>3</sup>)<sub>m</sub>-, O, S or NR<sup>4</sup>, wherein each R<sup>3</sup> is independently hydrogen, hydroxy or a lower alkyl group having 1 to 6 carbon atoms, R<sup>4</sup> is hydrogen or a lower alkyl group having 1 to 6 carbon atoms and m is 0, 1 or 2;

R<sup>5</sup> is hydrogen or hydroxy; and

Y is O, S, NR<sup>4</sup> or is a single bond.

29. A method for treating disorders responsive to the selective blockade of N-methyl-D-aspartate receptor subtypes in an animal suffering thereof which comprises administering in unit dosage form of at least one



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selective N-methyl-D-aspartate receptor subtype antagonist compound selected from the group consisting of:

- 1- (2-Phenoxyethyl) -4-phenylpiperidine;
- 1- (4- (3- (Trifluoromethyl)phenoxy) butyl) -4-phenylpiperidine;
- 4-Phenoxy-1- [ (4-fluorophenoxy) propyl] piperidine;
- 1- (3-Phenoxypropyl) -4-phenylpiperidine;
- 1- (2-Phenoxyethyl) -4-phenylpiperidine;
- 1- (4-Phenoxybutyl) -4-phenylpiperidine;
- 1- (4- (3- (Trifluoromethyl)phenoxy) butyl) -4-phenylpiperidine;
- 1- (2- (4-Aminophenoxy) ethyl) -4-benzylpiperidine;
- 3- ( (2- (4-Benzylpiperidin-1-yl) ethyl) oxy) -benzaldehyde;
- 3- ( (2- (4-Benzylpiperidin-1-yl) ethyl) oxy) -benzaldehyde oxime;
- 4-Benzyl-1- (2- (3- (ethoxycarbonylmethyl) -phenoxy) ethyl) piperidine;
- 4-Benzyl-1- (2- (3- (2-hydroxyethyl) phenoxy) ethyl) piperidine;
- 1- (2- (3- (Aminocarbonylmethyl) phenoxy) ethyl) -4-benzylpiperidine;
- 4-Benzyl-1- (2- (3- (hydrazinocarbonylmethyl) -phenoxy) ethyl) piperidine;
- 4-Benzyl-1- (1-methyl-2-phenoxyethyl) piperidine;
- 4-Benzyl-1- (3- (3-fluorophenoxy) propyl) piperidine;
- 4-Benzyl-1- (4- (3-fluorophenoxy) butyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (2-phenoxyethyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (2- (4-fluorophenoxy) -ethyl) piperidine;
- 4- (4-Chlorobenzyl) -1- (2- (4-chlorophenoxyethyl) -piperidine;
- 4- (4-Chlorobenzyl) -1- (2- (4-nitrophenoxy) -ethyl) piperidine;

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1-(2-(4-Aminophenoxy)ethyl)-4-(4-chlorobenzyl)-  
piperidine;  
4-(4-Chlorobenzyl)-1-(2-(3-(2-  
hydroxyethyl)phenoxy)-ethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(3-phenoxypropyl)piperidine;  
4-(4-Chlorobenzyl)-1-(3-(3-fluorophenoxy)-  
propyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)-  
piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-chlorophenoxy)-  
ethyl)piperidine;  
1-(2-(4-Fluorophenoxy)ethyl)-4-(4-methoxybenzyl)-  
piperidine;  
1-(2-(4-Fluorophenoxy)ethyl)-4-(4-nitrobenzyl)-  
piperidine;  
4-(4-Nitrobenzyl)-1-(3-phenoxypropyl)piperidine;  
4-Benzyl-1-(1-methyl-3-phenoxypropyl)piperidine;  
4-(4-Chlorophenyl)-4-hydroxy-1-(2-phenoxyethyl)-  
piperidine;  
1-(2-Phenoxyethyl)-4-phenylpiperidine;  
4-(4-Chlorophenyl)-4-hydroxy-1-(3-phenoxypropyl)-  
piperidine;  
3-Hydroxy-1-(2-phenoxyethyl)-4-(3-  
trifluoromethylphenyl)piperidine;  
3-Hydroxy-1-(3-phenoxypropyl)-4-(3-  
trifluoromethylphenyl)piperidine;  
4-Benzyl-1-[2-(6-quinolinoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(8-quinolinoxy)ethyl]piperidine;  
4-Benzyl-1-[2-(2-amino-3-nitrophenoxy)ethyl]-  
piperidine;  
4-Benzyl-1-[2-(2,3-diaminophenoxy)ethyl]-  
piperidine;  
4-Benzyl-1-[2-(2,3-dioxoquinoxalin-5-oxo)-  
ethyl]piperidine;  
4-Benzyl-1-[2-(2-oxobenzimidazol-4-oxo)-  
ethyl]piperidine;

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4-Benzyl-1-[2-(4-amino-3-nitrophenoxy)  
ethyl]piperidine;  
4-Benzyl-1-[2-(3,4-diaminophenoxy) -  
ethyl]piperidine;  
4-Benzyl-1-[2-(2,3-dioxoquinoxalin-6-oxy) -  
ethyl]piperidine;  
4-Benzyl-1-[2-(2-oxobenzimidazol-5-oxy) -  
ethyl]piperidine;  
4-Benzyl-1-[2-(2-nitrophenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(2-aminophenoxy) ethyl]piperidine  
4-Benzyl-1-[2-(3-nitrophenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(3-aminophenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(4-nitrophenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(4-aminophenoxy) ethyl]piperidine;  
4-[2-(4-Benzylpiperidinoethoxy) quinazoline;  
4-[2-(4-Benzylpiperidino) ethoxy] pyrazolo-[3,4-  
d]pyrimidine;  
1-[2-(4-Benzylpiperidino) -ethyl]-4-  
hydroxypyrazolo[3,4-d]pyrimidine;  
4-Benzyl-1-[2-(2-methoxyphenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(3-methoxyphenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(4-methoxyphenoxy) ethyl]piperidine;  
4-Benzyl-1-[2-(3,4-bisacetamidophenoxy) ethyl] -  
piperidine;  
4-Benzyl-1-[2-(2-methylbenzimidazol-6-  
oxy) ethyl]piperidine;  
4-Benzyl-1-[2-(2-methylbenzimidazol-5-  
oxy) ethyl]piperidine;  
4-Benzyl-1-[2-(3-trifluoromethylphenoxy) -  
ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-nitrophenoxy) -  
ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-aminophenoxy) -  
ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-amino-3-nitrophenoxy)  
ethyl]piperidine;

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4-(4-Chlorobenzyl)-1-[2-(2,3-diaminophenoxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-4-oxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(4-amino-3-nitrophenoxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(3,4-diaminophenoxy)ethyl]piperidine;  
4-(4-Chlorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine;  
4-(4-fluorobenzyl)-1-[2-(2-oxobenzimidazol-5-oxy)ethyl]piperidine;  
4-Benzyl-1-(2-phenylethyl)piperidine;  
1,4-Dibenzylpiperidine;  
4-(4-Chlorophenyl)-4-hydroxy-1-(3-phenylpropyl)piperidine;  
4-(4-Chlorophenyl)-4-hydroxy-1-(4-phenylbutyl)piperidine;  
3-Hydroxy-1-(4-phenylbutyl)-4-(3-trifluoromethylphenyl)piperidine;  
4-Benzyl-4-hydroxy-1-(2-phenylethyl)piperidine;  
1,4-Dibenzyl-4-hydroxypiperidine;  
1-Benzyl-4-(4-fluorobenzyl)-4-hydroxypiperidine;  
4-(4-Fluorobenzyl)-1-[2-(4-fluorophenyl)ethyl]-4-hydroxy piperidine;  
4-(2-Keto-1-benzimidazoliny)-1-(3-phenoxypropyl)-piperidine;  
4-Benzyl-1-(2-phenoxyethyl)piperidine;  
4-Benzyl-1-(3-phenoxypropyl)piperidine;  
4-Benzyl-1-(3-phenylpropyl)piperidine;  
4-Benzyl-1-[2-(3-phenoxy)propyl]piperidine;  
4-Benzyl-1-[2-hydroxy-3-(1-naphthyloxy)propyl]piperidine;  
4-Benzyl-4-hydroxy-1-(3-phenylpropyl)piperidine;  
4-Benzyl-4-hydroxy-1-(3-phenoxypropyl)piperidine;  
4-Benzyl-1-[(2-hydroxy-4-phenyl)butyl]piperidine;  
1-(3-Phenoxypropyl)-4-phenyl piperidine;

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1-(4-Phenoxybutyl)-4-phenyl piperidine;  
4-Phenoxy-1-[(4-fluorophenoxy)propyl]piperidine;  
4-(2-Methoxyphenoxy)-1-(4-phenylbutyl)piperidine;  
4-Benzyl-1-(4-phenylbutyl)piperidine;  
4-[(3-Trifluoromethylphenyl)methyl]-1-[2-(3-aminophenoxy)ethyl]piperidine;  
4-[(3-Trifluoromethylphenyl)methyl]-1-[3-(3-aminophenoxy)propyl]piperidine;  
3-Hydroxy-4-(3-trifluoromethylphenyl)-1-[3-(3-aminophenoxy)propyl]piperidine;  
3-Hydroxy-4-(4-fluorophenyl)-1-[3-(3-amino-1-naphthyloxy)propyl]piperidine;  
4-Benzyl-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Hydroxybenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine;  
4-Benzyl-1-(3-(4-hydroxyphenyl)propyl)piperidine;  
4-(4-Chlorobenzyl)-1-(3-(4-hydroxyphenyl)propyl)piperidine;  
4-Benzyl-1-(2-(4-hydroxyphenyl)ethyl)piperidine;  
4-(3-Fluorobenzyl)-1-(2-(4-fluorophenoxy)ethyl)piperidine;  
4-(4-Methylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Ethylbenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Methoxybenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(3,4-Difluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-4-hydroxy-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;  
4-(2-Fluorobenzyl)-1-(2-(4-hydroxyphenoxy)ethyl)piperidine;

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4- (4-Trifluoromethylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4- (4-Isopropylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4- (4-t-Butylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4- (2-Fluoro-4-methylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4- ((5,6,7,8-tetrahydro-2-naphthyl)methyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4- ((2-Naphthyl)methyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4-Benzyl-1- (2- (N-methylanilino) ethyl) piperidine;  
4-Benzyl-1- (2- (thiophenoxy) ethyl) piperidine;  
4- (4-Chlorobenzyl) -1- (2- (2-chloro-4- (2-hydroxyethyl) phenoxy) ethyl) piperidine;  
4- (2,6-Difluorobenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4- (2-fluoro-4-methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;  
4-Benzyl-1- (2- (3,4-methylenedioxyphenoxy) ethyl) piperidine;  
4- (2-Fluoro-4-methylbenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;  
4- (4-Fluorobenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;  
4- (4-Methylbenzyl) -1- (2- (3-fluoro-4-hydroxyphenoxy) ethyl) piperidine;  
4- (4-Fluorobenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;  
4- (4-Methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;  
4-Hydroxy-4- (4-methylbenzyl) -1- (2- (4-hydroxyphenoxy) ethyl) piperidine;  
4-Hydroxy-4- (4-methylbenzyl) -1- (2- (4-hydroxy-3-methylphenoxy) ethyl) piperidine;  
4-Benzyl-1- (2- (2-hydroxyphenoxy) ethyl) piperidine;

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4-Benzyl-1-(2-(3-hydroxyphenoxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(2-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Fluorobenzyl)-1-(2-(3-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Methylbenzyl)-1-(2-(2-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Methylbenzyl)-1-(2-(3-hydroxyphenoxy)ethyl)  
piperidine;  
4-Benzyl-1-(2-(N-methyl-4-hydroxyanilino)ethyl)  
piperidine;  
4-Benzyl-4-hydroxy-1-(2-(4-hydroxyphenoxy)ethyl)  
piperidine;  
4-(4-Fluorobenzyl)-1-(2-(4-hydroxythiophenoxy)  
ethyl)piperidine;  
4-(4-hydroxyphenyl)-1-(4-phenylbutyl)piperidine;  
4-Benzyl-1-(3-(2-oxobenzimidazol-5-oxy)propyl)  
piperidine;  
4-Benzyl-1-(2-(2-thioxobenzimidazol-5-oxy)ethyl)  
piperidine;  
4-Benzyl-1-(2-(2-iminobenzimidazol-5-oxy)ethyl)  
piperidine;  
4-(4-Methylbenzyl)-1-(2-(2-thioxobenzimidazol-5-  
oxy)ethyl)piperidine;  
4-(4-Fluorobenzyl)-1-(2-(2-thioxobenzimidazol-5-  
oxy)ethyl)piperidine;  
4-(4-Chlorobenzyl)-1-(2-(2-thioxobenzimidazol-5-  
oxy)ethyl)piperidine;  
4-Benzyl-1-(2-(2-oxobenzoxazol-5-oxy)ethyl)  
piperidine;  
4-Benzyl-1-(2-(2-oxobenzoxazol-6-oxy)ethyl)  
piperidine;  
4-Benzyl-1-(2-(2-hydroxynaphth-6-oxy)ethyl)  
piperidine;  
4-Benzyl-1-(2-(3-hydroxynaphth-6-oxy)ethyl)  
piperidine;

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4-(4-Fluorobenzyl)-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine;

4-(4-Methylbenzyl)-1-(2-(2-hydroxynaphth-6-oxy)ethyl)piperidine;

4-Benzyl-1-(2-(3-methyl-2-oxobenzimidazol-5-oxy)ethyl)piperidine;

4-Benzyl-1-(2-(2-oxo-1,3-dihydroindol-5-oxy)ethyl)piperidine;

4-(4-Fluorobenzyl)-1-(2-(2-oxo-1,3-dihydroindol-5-oxy)ethyl)piperidine; and a pharmaceutically acceptable salt of any thereof.

30. The method according to any one of claims 18 to 29, wherein said disorder is stroke, cerebral ischemia, central nervous system trauma or hypoglycemia.

31. The method according to any one of claims 18 to 29, wherein said disorder is psychosis, anxiety, convulsions or chronic pain.

32. The method according to any one of claims 18 to 29, wherein said disorder is a neurodegenerative disorder.

33. The method according to any one of claims 18 to 29, wherein said disorder is a migraine headache.

34. The method according to any one of claims 18 to 29, wherein said disorder is opioid tolerance or withdrawal.

35. The method according to any one of claims 18 to 29, wherein said disorder is glaucoma or CMV retinitis.



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36. The method according to any one of claims 18 to 29, wherein said disorder is Parkinson's disease.

37. The method according to any one of claims 18 to 29, wherein said disorder is urinary incontinence.

38. The method according to any one of claims 18 to 29, wherein said disorder is aminoglycoside antibiotics-induced hearing loss.

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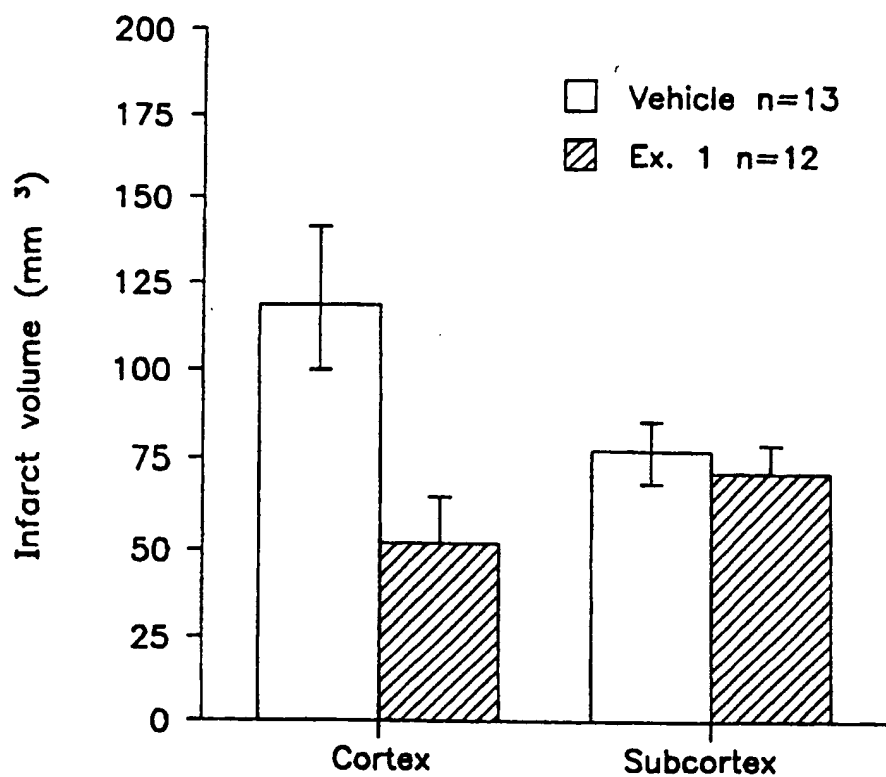


FIG. 1

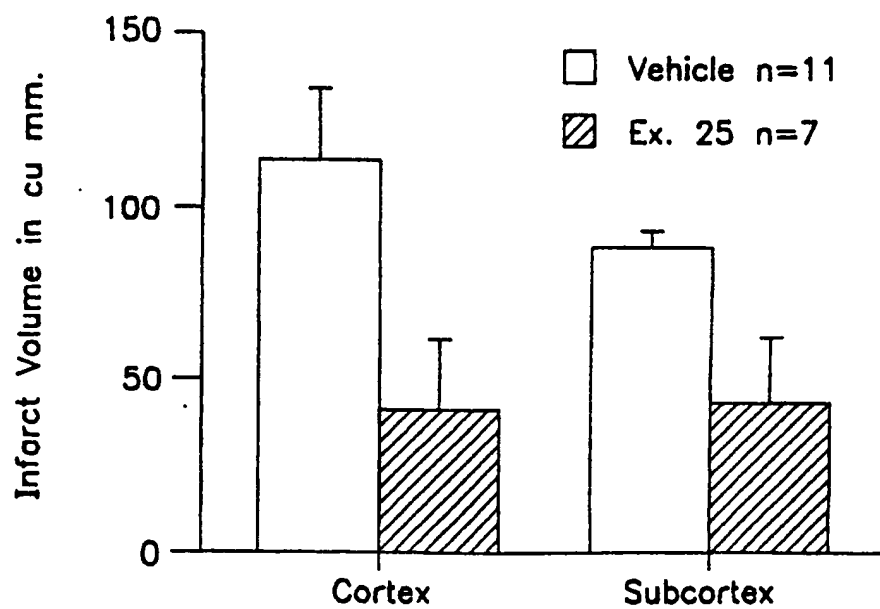


FIG. 2

SUBSTITUTE SHEET (RULE 26)

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/20872

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61K 31/445; C07D 211/14

US CL :546/236; 514/317

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 546/236; 514/317

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
CAS ONLINE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,091,616 A (PETROW ET AL) 28 May 1963 (28/05/63), see entire document.	1-38, parts

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* documents published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

11 MARCH 1997

Date of mailing of the international search report

27 MAR 1997

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

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Authorized officer

ROBERT W. RAMBUER

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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/20872

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☒ Claims Nos.: 1-38, parts  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
  
Please See Extra Sheet.
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/20872

### BOX I. OBSERVATIONS WHERE CLAIMS WERE FOUND UNSEARCHABLE

#### 2. Where no meaningful search could be carried out, specifically:

The multitude of variables and their permutations and combinations (e.g. Ar1,Ar2,z,X, R1, Y ,the provisos,etc.) result in claimed subject matter that is so broad in scope that it is rendered virtually incomprehensible and thus no meaningful search can be given. Note also that the claimed subject matter lacks a significant structural element qualifying as the special technical feature that clearly defines a contribution over the art. The subject matter claimed contains a C-C-N-C-C group which does not define a contribution over the prior art. Therefore, the first discernable invention as found in Example 1,(the compound therein, the pharmaceutical composition therewith, and the method of treating stroke therewith) has been searched.